



Williston Ice & Turf Facility

PROJECT MANUAL Volume 2 of 2: Divisions 21-33

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408 Airport Rd.
Williston, ND 58801

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ISSUED BY:
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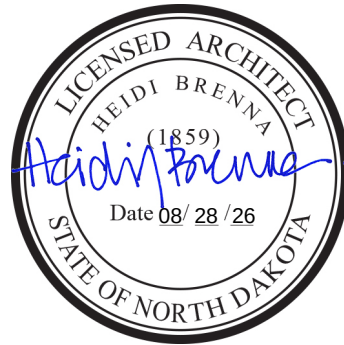


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SEALS PAGE**

1.01 DESIGN PROFESSIONALS OF RECORD

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2. ICON Architectural Group



B. Landscape Architect:

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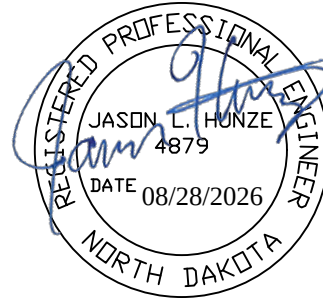


C. Mechanical Engineer:

1. Josh D. Lunski, PE, FPE, HFDP
2. Martin Mechanical Design Inc



- D. Electrical Engineer:
1. Jason Hunze, PE
 2. Prairie Engineering, PC



- E. Ice Engineer
1. Scott A. Ward, PE
 2. B32 Engineering Group, Inc.



- F. Structural Engineer
1. Michael Jochim, PE
 2. ICON Architectural Group



- G. Civil Engineer
1. William J. Moonen, PE
 2. AE2S



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END OF SECTION

Legend:

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Structural Engineers	ICON Architectural Group (S)
Mechanical Engineers	Martin Mechanical (M)
Electrical Engineers	Prairie Engineering (E)
Ice Consultant	B32 Engineering Group (I)
Food Consultant	Foodservice Concept Design (F)
Landscape Architect	Interstate Engineering (L)
Civil Engineer	AE2S (C)
Construction Manager	JE Dunn (CM)

SECTION 21 0500
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Above ground piping.
- B Escutcheons.
- C Expansions - hose and braid.
- D Mechanical couplings.
- E Pipe hangers and supports.
- F Pipe sleeves.
- G Piping specialties.
- H Pressure gauges.

1.02 REFERENCE STANDARDS

- A ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
- B ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- D ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- E ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).
- F ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- G ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe; 2021.
- H ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- I ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use; 2021.
- J ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.
- K AWWA C606 - Grooved and Shouldered Joints; 2022.
- L FM (AG) - FM Approval Guide; Current Edition.
- M ITS (DIR) - Directory of Listed Products; Current Edition.
- N NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- O NFPA 1963 - Standard for Fire Hose Connections; 2019.
- P UL (DIR) - Online Certifications Directory; Current Edition.
- Q UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
- R UL 405 - Standard for Safety Fire Department Connection Devices; Current Edition, Including All Revisions.

1.03 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified in this section.
- C Comply with FM (AG), UL (DIR), and ITS (DIR) or Warnock Hersey requirements.
- D Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

- A Deliver and store valves in shipping containers, with labeling in place.
- B Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.05 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

- A Sprinkler-based System:
 - 1. Comply with NFPA 13.
 - 2. See Section 21 1300.
- B Welding Materials and Procedures: Comply with ASME BPVC-IX.
- C Provide system pipes, fittings, sleeves, escutcheons, seals, and other related accessories.

2.02 ABOVE GROUND PIPING

- A Steel Pipe: ASTM A795 Schedule 10, ASTM A135/A135M Schedule 10, or ASTM A795 Schedule 40, galvanized for dry systems and areas within the Ice Rinks.
- B Steel Pipe: ASTM A795 Schedule 10, ASTM A135/A135M Schedule 10, or ASTM A795 Schedule 40, black for wet systems outside the Ice Rinks.
 - 1. Steel Fittings: ASME B16.5 steel flanges and fittings.
 - 2. Malleable Iron Fittings: ASME B16.3, threaded fittings and ASTM A47/A47M.
 - 3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.03 PIPE SLEEVES

- A Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
- B Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- C Clearances:

1. Provide allowance for insulated piping.
2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
3. Rated Openings: Caulked tight with firestopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.04 ESCUTCHEONS

- A Material:
 1. Chrome-plated.
 2. Metals and Finish: Comply with ASME A112.18.1.
- B Construction:
 1. One-piece for mounting on chrome-plated tubing or pipe and one-piece or split-pattern type elsewhere.
 2. Internal spring tension devices or setscrews to maintain a fixed position against a surface.

2.05 PIPE HANGERS AND SUPPORTS

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

2.06 EXPANSION JOINTS AND LOOPS - HOSE AND BRAID

- A Manufacturers:
 1. The Metraflex Company; FireLoop: www.metrafire.com/#sle.
 2. Flex-Hose Co. Inc: www.flexhose.com/#sle.
 3. Flex-Weld, Inc: www.kelcoind.com/#sle.
- B Provide flexible loops with two flexible sections of hose and braid, two 90-degree elbows, and 180-degree return with support bracket and air release or drain plug.
- C Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
- D Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 1. Maximum Allowable Working Pressure: 150 psig at 120 degrees F.
 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: 4 inch.
 - b. Lateral Movement: 4 inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 3. End Connections: Same as specified for pipe jointing.

4. Provide necessary accessories including, but not limited to, swivel joints.

2.07 MECHANICAL COUPLINGS

A Manufacturers:

1. Anvil International: www.anvilintl.com/#sle.
2. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
3. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
4. Victaulic Company; FireLock Style 009H: www.victaulic.com/#sle.

B Rigid Mechanical Couplings for Grooved Joints:

1. Dimensions and Testing: Comply with AWWA C606.
2. Minimum Working Pressure: 300 psig.
3. Housing Material: Fabricate of ductile iron complying with ASTM A536.
4. Housing Coating: Factory applied orange enamel.
5. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
6. Bolts and Nuts: Hot-dipped-galvanized or zinc-electroplated steel.

2.08 PIPING SPECIALTIES

A Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber-faced clapper to automatically actuate water motor alarm, pressure retard chamber and variable pressure trim with the following additional capabilities and features:

1. Activate electric alarm.
2. Test and drain valve.
3. Replaceable internal components without removing valve from installed position.

B Auxiliary Drains: Condensate collection drain for each section of trapped pipe in preaction or dry fire protection system.

C Air Venting Valves:

D Backflow Preventer: Double-check valve assembly backflow preventer with drain and OS & Y gate valve on each end.

E Test Connections:

1. Inspector's Test Connection for Preaction and Dry Pipe Systems:
 - a. Provide test connections approximately 6 feet above floor for each or portion of each sprinkler system equipped with an alarm device, located at most remote part of each system.
 - b. Route test connection to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
 - c. Supply discharge orifice with same size as corresponding sprinkler orifice.
 - d. Limit vertical height of exterior wall penetration to 2 feet above finished grade.
2. Combination Inspector's Test Connection and Drain Valve:
 - a. Provide test connections approximately 6 feet above floor for each or portion of each sprinkler system equipped with an alarm device, located at most remote part of each system.

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- b. Route combination test connection and drain valve to an open-site drain location, excluding janitor sinks, accepting full flow without negative consequences.
 - c. Supply discharge orifice with same size as corresponding sprinkler orifice.
 - d. Limit vertical height of exterior wall penetration to 2 feet above finished grade.
- 3. Backflow Preventer Test Connection:
 - a. Provide downstream of the backflow prevention assembly, listed hose valves with 2.5-inch National Standard male hose threads with cap and chain.
 - b. Provide one valve for each 250 gpm of system demand or fraction thereof.
 - c. Provide permanent sign reading "Test Valve." See Section 21 0553.
- F Electric Alarm: Electrically operated chrome-plated gong with pressure alarm switch.
- G Water Flow Switch: Vane-type switch for mounting horizontally or vertically, with two contacts; rated 10 A at 125 VAC and 2.5 A at 24 VDC.
- H Fire Department Connections:
 - 1. Type: Exposed, projected wall mount made of corrosion-resistant metal complying with UL 405.
 - a. Inlets: Two-way, 2-1/2 inch swivel fittings, internal threaded. Thread size and inlets according to NFPA 1963 or authority having jurisdiction. Brass caps with gaskets, chains, and lugs.
 - b. Configuration: Horizontal.
 - c. Outlet: Back with pipe threads, 4 NPS.
 - d. Rated Working Pressure: 175 psi.
 - e. Finish: Brass or bronze.

2.09 PRESSURE GAUGES

- A Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Diameter: 4-1/2 inch.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Display in psi and kPa.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
- B Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C Install piping to conserve building space, to not interfere with use of space and other work.

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- D Group piping whenever practical at common elevations.
- E Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- G Pipe Hangers and Supports:
 - 1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 2. Place hangers within 12 inches of each horizontal elbow.
 - 3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- I Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- J Structural Considerations:
 - 1. Do not penetrate building structural members unless indicated.
- K Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- L Escutcheons:
 - 1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
 - 2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
 - 3. Attach plates at the underside only of suspended ceilings.
 - 4. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.
- M When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.

3.03 CLEANING

- A Upon completion of work, clean all parts of the installation.

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FOR FIRE SUPPRESSION

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- B Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 21 0500

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SECTION 21 0523

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

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Check valves.
- B Bronze OS&Y gate valves.
- C Iron OS&Y gate valves.
- D NRS gate valves.
- E Trim and drain valves.

1.02 RELATED REQUIREMENTS

- A Section 21 0553 - Identification for Fire Suppression Piping and Equipment.

1.03 ABBREVIATIONS AND ACRONYMS

- A NRS: Non-rising stem.
- B OS&Y: Outside screw and yoke.
- C PTFE: Polytetrafluoroethylene.
- D SBR: Styrene-butadiene rubber.

1.04 REFERENCE STANDARDS

- A AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.
- B AWWA C606 - Grooved and Shouldered Joints; 2022.
- C FM (AG) - FM Approval Guide; Current Edition.
- D NFPA 13 - Standard for the Installation of Sprinkler Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E NFPA 13R - Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies; 2025.
- F UL (DIR) - Online Certifications Directory; Current Edition.
- G UL 262 - Gate Valves for Fire-Protection Service; Current Edition, Including All Revisions.
- H UL 312 - Check Valves for Fire-Protection Service; Current Edition, Including All Revisions.

1.05 SUBMITTALS

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

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications:
 - 1. Obtain valves for each valve type from single manufacturer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Set valves open to minimize exposure of functional surfaces.
- B Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors and maintain at higher than ambient dew point temperature.
 - b. If outdoor storage is unavoidable, store valves off the ground in watertight enclosures.
- C Use the following precautions for handling:
 - 1. Do not use operating handles or stems as lifting or rigging points.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A UL Listed: Provide valves listed in UL (DIR) under following headings and bearing UL mark:
 - 1. Main Level: HAMV - Fire Main Equipment.
 - a. Level 3: HLUG - Ball Valves, System Control.
 - b. Level 3: HMER - Check Valves.
 - 2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.
 - a. Level 1: VQGU - Valves, Trim, and Drain.
- B FM Global Approved: Provide valves listed in FM (AG) Approval Guide under the following headings:
 - 1. Automated Sprinkler Systems:
 - a. Indicator posts.
 - b. Valves:
 - 1) Gate valves.
 - 2) Single check valves.
 - 3) Miscellaneous valves.
- C ASME Compliance:
- D Comply with AWWA C606 for grooved-end connections.
- E Comply with NFPA 13 and NFPA 13R for valves.
- F Valve Pressure Ratings: Not less than minimum pressure rating indicated or higher as required.
- G Valve Sizes: Same as upstream piping unless otherwise indicated.

2.02 CHECK VALVES

- A UL 312 and FM (AG) standard listing for check valves, Class Number 1045.
- B AWWA C508 compliant check valves.
- C Minimum Pressure Rating: 175 psig.
- D Type: Center guided check valve.

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- E Body Material: Cast iron, ductile iron.
- F Center guided check with elastomeric seal.
- G Hinge Spring: Stainless steel.
- H End Connections: Flanged, grooved, or threaded.

2.03 BRONZE OS&Y GATE VALVES

- A UL 262 and FM (AG) standard listing for fire-service water control valves (OS&Y and NRS-type gate valves).
- B Minimum Pressure Rating: 175 psig.
- C Body and Bonnet Material: Bronze or brass.
- D Wedge: One-piece bronze or brass.
- E Wedge Seat: Bronze.
- F Stem: Bronze or brass.
- G Packing: Non-asbestos PTFE.
- H Supervisory Switch: External.
- I End Connections: Threaded.

2.04 IRON OS&Y GATE VALVES

- A Listed and Body Marked: AWWA C509, FM (AG), and UL 262.
- B Size: As indicated on drawings.
- C End Connections: Flanged.
- D Maximum Working Pressure: 175 psi.
- E Body and Bonnet Material: Cast or ductile iron.
- F Wedge: Cast or ductile iron, or bronze with elastomeric coating.
- G Stem: Brass, bronze, or stainless steel.
- H Packing: Non-asbestos PTFE.
- I Supervisory Switch: External.

2.05 NRS GATE VALVES

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

2.06 TRIM AND DRAIN VALVES

- A Ball Valves:
 - 1. Description:
 - a. Pressure Rating: 175 psig.

GENERAL-DUTY VALVES
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- b. Body Design: Two piece.
- c. Body Material: Forged brass or bronze.
- d. Port Size: Full or standard.
- e. Seat: PTFE.
- f. Stem: Bronze or stainless steel.
- g. Ball: Chrome-plated brass.
- h. Actuator: Hand-lever.
- i. End Connections for Valves 1 NPS through 2-1/2 NPS: Threaded ends.
- j. End Connections for Valves 1-1/4 NPS and 2-1/2 NPS: Grooved ends.

PART 3 EXECUTION

3.01 EXAMINATION

- A Confirm valve interior to be free of foreign matter and corrosion.
- B Remove packing materials.
- C Examine guides and seats by operating valves from the fully open position to the fully closed position.
- D Examine valve threads and mating pipe for form and cleanliness.

3.02 INSTALLATION

- A Comply with specific valve installation requirements and application in the following Sections:
 - 1. Section 21 1300 for application of valves in wet and dry pipe, fire-suppression sprinkler systems.
- B Install listed fire protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections.
 - 1. Install permanent identification signs indicating portion of system controlled by each valve.
- C Install check valve in water supply connections and backflow preventer at potable water supply connections.
- D Valves in horizontal piping installed with stem at or above the pipe center.
- E Position valves to allow full stem movement.
- F Install valve tags. Comply with Section 21 0553 requirements for valve tags, schedules, and signs on surfaces concealing valves; and the appropriate NFPA standard applying to the piping system in which valves are installed.

END OF SECTION 21 0523

SECTION 21 0553

IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 REFERENCE STANDARDS

- A ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.
- B ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2025.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D Product Data: Provide manufacturers catalog literature for each product required.
- E Manufacturer's Installation Instructions: Indicate special procedures, and installation instructions.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A Automatic Controls: Tags.
- B Control Panels: Nameplates.
- C Major Control Components: Nameplates.
- D Pumps: Nameplates.

2.02 NAMEPLATES

- A Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Red.
 - 4. Thickness: 1/8 inch.
 - 5. Plastic: Comply with ASTM D709.

2.03 TAGS

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

2.04 PIPE MARKERS

- A Manufacturers:
- B Color: Comply with ASME A13.1.

- C Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- E Color code as follows:
 - 1. Fire Quenching Fluids: Red with white letters.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B Install tags with corrosion resistant chain.
- C Install plastic pipe markers in accordance with manufacturer's instructions.
- D Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

END OF SECTION 21 0553

**SECTION 21 1300
FIRE-SUPPRESSION SPRINKLER SYSTEMS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A System design, installation, and certification.

1.02 ADMINISTRATIVE REQUIREMENTS

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

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C Shop Drawings:
 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components, and accessories. Indicate system controls.
- D Designer's qualification statement.
- E Manufacturer's qualification statement.
- F Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- G Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 1. See Section 01 6000 - Product Requirements for additional provisions.
 2. Extra Sprinklers: Type and size matching those installed in quantity required by referenced NFPA design and installation standard.
 3. Sprinkler Wrenches: For each sprinkler type.
- H Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

1.04 QUALITY ASSURANCE

- A Comply with FM (AG) requirements.
- B Designer Qualifications: Design system under direct supervision of a Professional Fire Protection Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- C Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Sprinklers, Valves, and Equipment:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Tyco Fire Protection Products: www.tyco-fire.com/#sle.
 3. Reliable
 4. Viking Corporation: www.vikinggroupinc.com/#sle.

2.02 SPRINKLER SYSTEM

- A Sprinkler System: Provide coverage for entire building.
- B Occupancy: See Plan for Hazzard Classifications in all area.
- C Water Supply: Determine volume and pressure from water flow test data.
 1. If test data is not available, assume 1620 gpm at 20 psig.
 2. Revise design when test data available prior to submittals.
- D Interface system with building control system.
- E Provide fire department connections where indicated.
- F Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.03 SPRINKLERS (SEE PLANS ALSO FOR ADDITIONAL NOTES)

- A Suspended Ceiling Type: Recessed pendant type with matching push on escutcheon plate.
 1. Response Type: Quick.
 2. Coverage Type: Extended.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Enamel, color white.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B Exposed Area Type: Pendant type with guard.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C Sidewall Type: Semi-recessed horizontal sidewall type with matching push on escutcheon plate.
 1. Response Type: Quick.
 2. Coverage Type: Standard.
 3. Finish: Brass.
 4. Escutcheon Plate Finish: Enamel, color as selected.
 5. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- D Storage Sprinklers: Pendant type with guard.
 1. Response Type: Standard.
 2. Coverage Type: Standard.
 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- E Guards: Finish to match sprinkler finish.
- F Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.

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1. Finish: Brass.
- G Flexible Drop System: Stainless steel, multiple use, open gate type.
1. Application: Use to properly locate sprinkler heads in all drop ceiling areas and as noted otherwise.
 2. Include all supports and bracing.
 3. Provide braided type tube as required for the application.
 4. Manufacturers:
 - a. FlexHead Industries, a brand of Anvil International: www.anvilintl.com/#sle.
 - b. Victaulic Company; Vic-Flex: www.victaulic.com/#sle.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with referenced NFPA design and installation standard.
- B Install equipment in accordance with manufacturer's instructions.
- C Provide approved backflow preventer assembly at sprinkler system water source connection.
- D Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.
- E Place pipe runs to minimize obstruction to other work.
- F Place piping in concealed spaces above finished ceilings.
- G Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- H Flush entire piping system of foreign matter.
- I Install guards on sprinklers where indicated.
- J Hydrostatically test entire system.
- K Require test be witnessed by Fire Marshal.

END OF SECTION 21 1300

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**SECTION 22 0500
BASIC PLUMBING REQUIREMENTS**

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. General Plumbing Requirements specifically applicable to all Division 22 Sections.
 2. Some piping material and installation instructions common to most piping systems.
 3. Equipment installation requirements common to equipment sections.

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, 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 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 Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 1. Any item listed as furnished shall also be installed, unless otherwise noted.
 2. Any item listed as installed shall also be furnished, unless otherwise noted.

1.04 REFERENCES AND STANDARDS:

- A The editions recognized by latest adopted versions of the following are hereby included in and made a part of Division 22:
 1. National Fire Protection Association
 2. Underwriters' Laboratories, Inc.
 3. American Welding Society
 4. American National Standards Institute
 5. American Gas Association
 6. Occupational Safety and Health Act
 7. Cast Iron Soil Pipe Institute

1.05 QUALITY ASSURANCE AND COORDINATION**A Contractor's Responsibility Prior to Submitting Pricing Data:**

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B Electrical Characteristics for 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 at no cost to the owner. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.**C Compliance with Codes, Laws, Ordinances:**

1. Conform to all requirements of the Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All work to meet in-force local plumbing code. In the case of discrepancies between the project contract documents and the in-force local code, the most stringent shall govern.

D Engineer or plumbing staff shall walk through and inspect all plumbing work prior to walls or ceilings being closed up, deficiencies shall be noted and given to the project manager in writing. Notify Engineer when project is ready for above ceiling inspection.

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- E All materials and installations shall meet applicable FM Global requirements.
- F Permits, Fees, Taxes, Inspections:
 - 1. Procure all applicable permits and licenses.
 - 2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
 - 3. Pay all charges for permits or licenses.
 - 4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
 - 5. Pay all charges arising out of required inspections by an authorized body.
 - 6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
 - 7. It is the sole responsibility of the contractor to obtain and procure permits. The Engineer is not liable for any costs associated with delays associated with permitting or obtaining permits under this division. The engineer at times may submit the plumbing permit in advance to help with project timeline. However, this fact does not relieve the installing contractor(s) from tracking and ensuring permitting process is being completed.
 - 8. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.
- G Utility Company Requirements:
 - 1. Secure from the appropriate private or public utility company all applicable requirements.
 - 2. Comply with all utility company requirements.
 - 3. Make application for and pay for service connections, such as gas.
 - 4. Make application for and pay for all meters and metering systems required by the utility company.
- H Examination of Drawings:
 - 1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
 - 2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
 - 3. Scaling of the drawings is not sufficient or accurate for determining these locations.
 - 4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
 - 5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
 - 6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
 - 7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.

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I Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

J Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit or Cadd platforms
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by Engineer.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by Engineer for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by Engineer as to the accuracy or correctness of the information provided. Engineer accepts no responsibility or liability for the Contractor's use of these documents.

1.06 SUBMITTALS

- A Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.
- B General Submittal Procedures: In addition to the provisions of Division 1, the following are required:
1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number

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- c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.

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- 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
- 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
- d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
- e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
 - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
 - b. The Contractor shall clearly indicate the size, finish, material, etc.
 - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
 - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.
8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer before
 - a. releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
- C Electronic Submittal Procedures:
 1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected.

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Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.

4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 2025-081SD 23 XX XX description.pdf
5. File Size: Electronic file size shall be limited to a maximum of 10MB. Larger files shall be transmitted via a pre-approved method.

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.
- C Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- D Coordinate the installation of heavy and large equipment with the Construction Manager or General Contractor. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- E Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.08 WARRANTY

- A Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship from date of substantial completion.
- B The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

1.09 COORDINATION

- A Contractor shall coordinate the work of the different trades so that interference between piping, equipment, structural, and electrical work will be avoided. All necessary offsets in piping and ductwork, and all fittings, and other components, required to install the work properly shall be furnished complete in place at no additional cost.

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1.10 MATERIAL SUBSTITUTION

- A Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

1.11 TESTING AND REPAIR

- A All piping and systems shall be thoroughly cleaned and flushed prior to final testing.
- B Pressure testing shall be completed for the following piping systems:
 - 1. Domestic water, sanitary and vent, storm and gas piping systems, and other systems as noted on the plans.
- C All testing must be witnessed and accurately recorded noting methods of testing, times, dates, and results.
- D Any damage as a result of tests shall be repaired or damaged materials replaced at no cost to the Owner.

1.12 FINAL COMPLETION

- A All work shall be cleaned prior to issuance of Substantial Completion.
- B Retouch or repaint factory painted prime and finish coats where scratched or damaged.
- C Deliver any equipment as required by this Specification to Owner and obtained signed receipts of delivery.
- D Clean equipment, restore damaged materials, and leave the Work in acceptable condition.
- E Remove all site tools, equipment, surplus materials and rubbish continuously at no additional cost to the Owner.
- F Contractor shall submit written certificates warranting each item of equipment.

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIALS:

- A All equipment and materials shall be furnished in strict accordance with the equipment named and according to Specification requirements. Each bid shall be based upon one of the materials or manufacturers specified.

- B Equipment and materials specified shall be considered to have prior approval, but submittal for approval is required. Furnish construction drawings to other Contractors when required to coordinate construction.
- C Where multiple manufacturers are named the drawings and specifications are based on the requirements and layouts for the equipment of the first named manufacturer. Any change required by the use of other named manufacturers such as revisions to foundations, bases, piping, controls, wiring, openings, and appurtenances shall be made by the Contractor at no additional cost to the Owner.

2.02 PIPE, TUBE, AND FITTINGS - GENERAL

- 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.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

- A All materials and/or equipment shall be installed per manufacturer's recommendations and instructions.
- B When temporary water is required, an approved backflow device shall be used and testing reports from device shall be sent to plumbing foreman for verification.
- C Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- D 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.
- E Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- F 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.
- G Piping shall not project beyond walls or steel lines nor shall it hang below slabs more than is absolutely necessary. Particular attention shall be paid to the required clearances.
- H Offset piping where required to avoid interference with other work, to provide greater headroom or clearance, or to conceal pipe more readily. Offsets shall be properly drained or trapped where necessary.
- I Provide swing joints and expansion bends wherever required to allow the piping to expand without undue stress to connections or equipment.
- J Exposed piping around fixtures or in other conspicuous places shall not show tool marks at fittings.
- K Isolate pipe from the building construction to prevent transmission of vibration to the structure and to eliminate noise.

- L Install piping such that any equipment connected to piping may be removed by disconnecting two (2) flanges or unions and removing only one or two pipe sections. All equipment shall have bolted or screwed flanges or unions at pipe connections.
- M Install fittings for changes in direction and branch connections. T-drill system for mechanically formed tee connections and couplings, and Victaulic hole cut piping system are not allowed.
- N Do not route piping through transformer vaults or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- O Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- P Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- Q Install piping to permit valve servicing.
- R Install piping at indicated slopes.
- S Install piping free of sags and bends.
- T Install piping to allow application of insulation.
- U Eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur due to a reduction in pipe size.
- V Cap and plug all openings in pipes during construction with suitable metal plugs or cap to keep out dirt and rubbish until equipment is connected.
- W Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- X Select system components with pressure rating equal to or greater than system operating pressure.
- Y 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.
- Z Verify final equipment locations for roughing-in.
- AA AA. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- BB BB. Provide proper access to materials and equipment that require inspection, repair, service, or maintenance.
- CC CC. Minimum service access size for materials equipment/components above ceilings shall be 24" square.
- DD All piping sized utilizing copper pipe as the base material. Installing contractor shall upsize piping according to ensure equal pressure drop. Changes to plumbing system to increase flow and reduce pressure drop to meet design shall be at the sole cost of the installing contractor.

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 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.

3.03 PIPING CONNECTIONS

- A Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of the equipment. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valves.

3.04 EXCAVATION, FILL, BACKFILL, COMPACTION

- A General:
 - 1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
 - 2. The Contractor shall do all excavating, filling, backfilling and compacting associated with his work.
- B Excavation:
 - 1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
 - 2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
 - 3. Trim bottom and sides of excavations to grades required for foundations.
 - 4. Protect excavations against frost and freezing.
 - 5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
 - 6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
 - 7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
 - 8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.
- C Dewatering:

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1. Contractor shall furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water to complete their work.
- D Underground Obstructions:
1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
 2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.
- E Fill and Backfilling:
1. No rubbish or waste material is permitted for fill or backfill.
 2. Provide all necessary sand for backfilling.
 3. Dispose of the excess excavated earth as directed.
 4. Backfill materials shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris or earth with a high void content.
 5. Backfill all trenches and excavations immediately after installing pipes, or removal of forms, unless other protection is provided.
 6. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.
 7. Lay all piping on a compacted bed of sand at least 3 inches deep. Backfill around pipes with sand, 6 inch layers, and compact each layer.
 8. Use sand for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand backfill to 6 inches above the top of the pipe.
 9. Place all backfill above the sand in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
 10. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.
- F Surface Restoration:
1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
 2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.05 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.

3.06 PROJECT CLOSEOUT

- A The following paragraphs supplement the requirements of Division 1.
- B Final Jobsite Observation:
 - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
 - 3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 - 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C Before final payment is authorized, this Contractor must submit the following:
 - 1. Operation and maintenance manuals with copies of approved shop drawings.
 - 2. Record documents including marked-up or reproducible drawings and specifications.
 - 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 - 4. Inspection by State Boiler Inspector.
 - 5. Start-up reports on all equipment requiring a factory installation inspection or start- up.
 - 6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.07 OPERATION AND MAINTENANCE MANUALS

- A General:
 - 1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as

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required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.

2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

B Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div22.contractor.YYYYMMDD
5. File Size: Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual in digital format which is tabbed and bookmarked accordingly.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.

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8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.08 RECORD DOCUMENTS

- A The following paragraph supplements Division 1 requirements:
 1. Contractor shall maintain at the job site a separate and complete set of mechanical drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the mechanical systems.
- B Mark drawings to indicate revisions to piping and plumbing systems size and location, both exterior and interior.
- C Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- D Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- E Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- F Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

END OF SECTION 22 0500

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SECTION 22 0517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A Section 07 8400 - Firestopping.
- B Section 22 0553 - Identification for Plumbing Piping and Equipment: Piping identification.
- C Section 22 0716 - Plumbing Equipment Insulation.
- D Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.
- B ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.
- C FM (AG) - FM Approval Guide; Current Edition.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

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

1.06 WARRANTY

- A See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A Manufacturers:
 - 1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.
 - 2. Metraflex.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.

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2. Provide sealant for watertight joint.
3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- C Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- D Pipe Passing Through Below Grade Exterior Walls:
 1. Zinc coated or cast iron pipe.
 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- E Clearances:
 1. Provide allowance for insulated piping.
 2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter.
 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
- F PIPE-SLEEVE SEALS
 1. Manufacturers:
 - a. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.
 - b. Metraflex
 2. Modular Mechanical Sleeve-Seal:
 - a. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
 - b. Watertight seal between pipe and wall-sleeve, wall or casing opening.
 - c. Size and select seal component materials in accordance with service requirements.
 - d. Service Requirements:
 - 1) Corrosion resistant.
 - 2) Underground, buried, and wet conditions.
 - e. Glass-reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B Install piping to conserve building space, to not interfere with use of space and other work.
- C Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

SLEEVES AND SLEEVE
SEALS FOR PLUMBING
PIPING

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- D Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- E Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a water-tight seal.
 - 6. Install in accordance with manufacturer's recommendations.
- F When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

END OF SECTION 22 0517

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SECTION 22 0519
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Pressure gauges.
- B Thermometers.
- C Pressure-temperature test plugs.

1.02 REFERENCE STANDARDS

- A ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- B ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).
- C ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.
- E UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide red-marked product data sheets for each furnished item with associated components and accessories.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Stainless Steel casing with brass or stainless burbon tube sensor.
 - 2. Size: 3-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.
 - 5. Liquid Filled: Glycerine

2.02 THERMOMETERS

- A General:
 - 1. Product Compliance: ASTM E1.
 - 2. Lens: Clear glass, except where stated.
 - 3. Accuracy: One percent, when tested in accordance with ASTM E77, except where stated.
 - 4. Scale: Black markings depicting single scale in degrees F where expected process value falls half-span of standard temperature range.
- B Thermometers - Adjustable Angle: 7 inch v-shape aluminum case with clear glass window scale, 6 inch NPT stem, red or blue organic non-toxic liquid filled glass tube, and adjustable

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joint with positive locking device allowing 360 degrees in horizontal plane or 180 degrees in vertical plane adjustments.

C Thermometers - Dial Type:

1. Fixed: 5 inch diameter dial with black pointer, stainless steel case, silicone damping bimetal element, hermetically sealed lens, recalibrating screw, and 2-1/2 inch NPT stem.

2.03 PRESSURE-TEMPERATURE TEST PLUGS:

A Size: 500 psi capacity; 1/2 inch MPT brass fitting with gasket, cap, and retaining strap for 1/8 inch pressure gauge or temperature probe.

B Wetted Materials per Temperature Range:

1. Up to 200 degrees F: Brass probe with neoprene core.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

A Install pressure gauges as follows:

1. At Pumps: Place single gauge before strainer, suction side and discharge side.
2. Include gauge cock to isolate each gauge and extend nipples for insulation clearance.

B Install thermometers as follows:

1. Hot Water Heaters: Place upstream and downstream of heater. Add one on the inlet end when using steam as the water heating medium.

END OF SECTION 22 0519

SECTION 22 0553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Stencils.
- B Pipe markers.

1.02 RELATED REQUIREMENTS

- A Section 09 9123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.

PART 2 PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A Stencil:
 - 1. Piping: 3/4 inch diameter and higher.
- B Pipe Markers: 3/4 inch diameter and higher.

2.02 STENCILS

- A Pipe: Stencil size required per external insulated or uninsulated pipe diameter.
 - 1. 3/4 to 1-1/4 inch Range: 1/2 inch text over 8 inch long background.
 - 2. 1-1/2 to 2 inch Range: 3/4 inch text over 8 inch long background.
 - 3. 2-1/2 to 6 inch Range: 1-1/4 inch text over 12 inch long background.
- B Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.
- C Fluid Service Identification Scheme, ASME A13.1:
 - 1. Water; Potable, Cooling, Boiler Feed and Other: White text on green background.

2.03 PIPE MARKERS

- A Comply with ASME A13.1.
- B Flexible Marker: Factory fabricated, semi-rigid, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid conveyed.
- C Flexible Tape Marker: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- D Identification Scheme, ASME A13.1:
 - 1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - a. 3/4 to 1-1/4 inches: Use 8 inch field-length with 1/2 inch text height.
 - b. 1-1/2 to 2 inches: Use 8 inch field-length with 3/4 inch text height.
 - c. 2-1/2 to 6 inches: Use 12 inch field-length with 1-1/4 inch text height.
 - d. 8 to 10 inches: Use 24 inch field-length with 2-1/2 inch text height.
 - 2. Secondary: Color scheme per fluid service.

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- a. Combustible Fluids: White text on brown background.
- b. Compressed Air: White text on blue background.
- c. Fire Quenching Fluids: White text on red background.
- d. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.
- 3. Tertiary: Other Details.
 - a. Directional flow arrow.

PART 3 EXECUTION

3.01 PREPARATION

- A Degrease and clean surfaces to receive identification products.

3.02 INSTALLATION

- A Apply stencil painted identification in compliance with Section 09 9123 requirements. Identify unit with assigned id-number and area being served using pipe marking rules.
- B Apply ASME A13.1 Pipe Marking Rules:
 - 1. Place pipe marker adjacent to changes in direction.
 - 2. Place pipe marker adjacent each valve port and flange end.
 - 3. Place pipe marker at both sides of floor and wall penetrations.
 - 4. Place pipe marker every 25 to 50 feet interval of straight run.

END OF SECTION 22 0553

**SECTION 22 0719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Glass fiber insulation.
- B Jacketing and accessories.

1.02 RELATED REQUIREMENTS

- A Section 07 8400 - Firestopping.

1.03 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 C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2024).
- D ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- E ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- F ASTM C1423 - Standard Guide for Selecting Jacketing Materials for Thermal Insulation; 2021.
- G ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- H ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- I SAE AMS3779 - Tape, Adhesive, Pressure-Sensitive Thermal Radiation Resistant, Aluminum Coated Glass Cloth; 2016b.
- J UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- C Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- B Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

- A Maintain ambient conditions required by manufacturers of each product.
- B Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

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

2.02 GLASS FIBER INSULATION

- A Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
- B Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm.
- D Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E Vapor Barrier Lap Adhesive: Compatible with insulation.
- F Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- G Insulating Cement: ASTM C449.
- H PVC fitting covers

2.03 JACKETING AND ACCESSORIES

- A PVC Plastic Jacket:
 - 1. Manufacturers:
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Brush on welding adhesive.
 - 3. Covering Adhesive Mastic: Compatible with insulation.
- B Reinforced Tape:

1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
2. Comply with UL 723 or ASTM E84.
3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.
4. Finish: Match insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that piping has been tested before applying insulation materials.
- B Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install in accordance with North American Insulation Manufacturers Association (NAIMA) National Insulation Standards.
- C Exposed Piping: Locate insulation and cover seams in least visible locations.
- D Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E Glass fiber insulated pipes conveying fluids below ambient temperature:
 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H Glass fiber insulated pipes conveying fluids above ambient temperature:
 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I Inserts and Shields:
 1. Application: Piping 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 3. Insert Location: Between support shield and piping and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

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

3.03 SCHEDULES

- A Insulation of Piping shall be in accordance with table C403.12.3 of the IECC 2024 addition
- B Domestic Hot Water and Recirculated Domestic Hot Water
 - 1. Pipe Size up to 1 1/2" = 1" Insulation
 - 2. Pipe Size Over 1 1/2" to 8" = 1.5" Insulation
- C Domestic Cold Water
 - 1. Pipe Size up to 1 1/2" = 1/2" Insulation
 - 2. Pipe Size Over 1 1/2" to 8" = 1.0" Insulation
- D Plumbing Systems:
 - 1. Roof Drain Bodies: 1" Fiberglass
 - 2. Roof Drainage Above Grade: 1" Fiberglass
 - 3. Roof Drainage Within 10 Feet of the Exterior: 1" Fiberglass
 - 4. Roof Drainage Run Horizontal at Roof Level: 1" Fiberglass

END OF SECTION 22 0719

**SECTION 22 1005
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Sanitary waste piping, buried within 5 feet of building.
- B Sanitary waste piping, above grade.
- C Domestic water piping, buried within 5 feet of building.
- D Domestic water piping, above grade.
- E Storm drainage piping, buried within 5 feet of building.
- F Storm drainage piping, above grade.
- G Pipe flanges, unions, and couplings.
- H Pipe hangers and supports.
- I Ball valves.
- J Butterfly valves.
- K Flow-balancing valves.
- L Strainers.

1.02 RELATED REQUIREMENTS

- A Section 22 0529 - Hangers and Supports for Plumbing Piping and Equipment.
- B Section 22 0553 - Identification for Plumbing Piping and Equipment.
- C Section 22 0719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

- A ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- B ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- C ASME B31.9 - Building Services Piping; 2020.
- D ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).
- E ASTM B32 - Standard Specification for Solder Metal; 2020.
- F ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2025.
- G ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- H ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- I ASTM B813 - Standard Specification for Water Flushable Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2024.
- J ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- K ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- L ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.

- 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 D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).
- O AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- P AWWA C651 - Disinfecting Water Mains; 2023.
- Q CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- R 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.
- S ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- T ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).
- U ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- V ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- W MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- X MSS SP-67 - Butterfly Valves; 2022.
- Y MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- Z NSF 61 - Drinking Water System Components - Health Effects; 2024.
- AA NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- D Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.

1.05 QUALITY ASSURANCE

- A Perform work in accordance with applicable codes.
- B Valves: Manufacturer's name and pressure rating marked on valve body.
- C Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

- E Mechanical Coupling for grooved installations shall have a labor and material warranty for 10 years. Including insurance for damaged caused by failure of 1 Million.
- F All plumbing piping has been sized by engineer utilizing copper domestic water piping. All other materials being utilized its the sole responsibility of the installing contractor to verify pipe pressure loss and upsize piping and fittings accordingly to match design pressure loss of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A PVC Pipe: ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY WASTE PIPING, ABOVE GRADE

- A Cast Iron Pipe: CISPI 301, hubless, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B PVC Pipe: ASTM D2665.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A Copper Pipe: ASTM B42, hard drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - 3. Joints: AWS A5.8M/A5.8, BCuP copper and silver braze.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

- A All piping sized utilizing copper pipe as the base material. Installing contractor shall modify piping sizes according to ensure equal pressure drop if other than copper piping is utilized. Changes after the fact to plumbing system to increase flow and reduce pressure drop to meet design shall be at the sole cost of the installing contractor.

- B Copper Pipe: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 2. Joints: ASTM B32, alloy Sn95 solder.
 3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Anvil International: www.anvilintl.com/#sle.
 - 2) FNW; Copper Press: www.fnw.com/#sle.
 - 3) Viega Propress.

2.06 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A PVC Pipe: ASTM D2665 or ASTM D3034.
1. Fittings: PVC.
 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.07 STORM DRAINAGE PIPING, ABOVE GRADE

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

2.08 PIPE FLANGES, UNIONS, AND COUPLINGS

- A Unions for Pipe Sizes 3 inch and Under:
1. Ferrous Pipe: Class 150 malleable iron threaded unions.
 2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
- B Flanges for Pipe Sizes Over 1 inch:
1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
 2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.09 PIPE HANGERS AND SUPPORTS

- A Provide hangers and supports that comply with MSS SP-58.
1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 4. Vertical Pipe Support: Steel riser clamp.
- B Plumbing Piping - Drain, Waste, and Vent:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.

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2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
3. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
4. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.

C Plumbing Piping - Water:

1. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
2. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 6 inch and Larger: Adjustable steel yoke, cast iron pipe roll, double hanger.
4. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.

D Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Comply with ICC-ES AC193.
2. Masonry Wedge Expansion Anchors: Comply with ICC-ES AC01.
3. Concrete Screw Type Anchors: Comply with ICC-ES AC193.
4. Masonry Screw Type Anchors: Comply with ICC-ES AC106.
5. Concrete Adhesive Type Anchors: Comply with ICC-ES AC308.

2.10 BALL VALVES

A Manufacturers:

1. Anvil International: www.anvilintl.com/#sle.
2. Apollo Valves: www.apollovalves.com/#sle.
3. Grinnell Products: www.grinnell.com/#sle.
4. Uponor, Inc: www.uponorengineering.com/#sle.
5. Viega
6. Victaulic

- B Construction, 4 inch and Smaller: MSS SP-110, Class 150, 600 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.11 BUTTERFLY VALVES

A Manufacturers:

1. Anvil International: www.anvilintl.com/#sle.
2. Apollo Valves: www.apollovalves.com/#sle.
3. Victaulic

- B Construction 1-1/2 inch and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.

- C Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.12 FLOW-BALANCING VALVES

- A Manufacturers:
 - 1. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

2.13 STRAINERS

- A Size 1/2 inch to 3 inch:
 - 1. Class 150, threaded forged bronze Y-pattern body, stainless steel perforated mesh screen with cap, and rated for 150 psi, 250 deg F WOG service.
- B Size 2 inch and Smaller:
 - 1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 - 2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
- C Size 1-1/2 inch to 4 inch:
 - 1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

PART 3 EXECUTION**3.01 EXAMINATION**

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- C Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- D PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- E Sleeve pipes passing through partitions, walls, and floors.
- F Inserts:
 - 1. Provide inserts for placement in concrete formwork.
- G Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.

3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 4. Place hangers within 12 inches of each horizontal elbow.
 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 8. Provide copper plated hangers and supports for copper piping.
 9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- H When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.04 APPLICATION

- A Use grooved mechanical couplings and fasteners only in accessible locations.
- B Install unions downstream of valves and at equipment or apparatus connections.
- C Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E Install globe or ball valves for throttling, bypass, or manual flow control services.
- F Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- G Provide spring-loaded check valves on discharge of water pumps.
- H Provide flow controls in water recirculating systems where indicated.

3.05 TOLERANCES

- A Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
- B Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 FIELD TESTS AND INSPECTIONS

- A Verify and inspect systems according to requirements by the Authority Having Jurisdiction. In the absence of specific test and inspection procedures proceed as indicated below.
- B Domestic Water Systems:
 1. Perform hydrostatic testing for leakage prior to system disinfection.
 2. Test Preparation: Close each fixture valve or disconnect and cap each connected fixture.
 3. General:
 - a. Fill the system with water and raise static head to 10 psi above service pressure. Minimum static head of 50 to 150 psi. As an exception, certain codes allow a maximum static pressure of 80 psi.
- C Test Results: Document and certify successful results, otherwise repair, document, and retest.

3.07 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A Prior to starting work, verify system is complete, flushed, and clean and complies with local regulations.
- B Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.
- D Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E Maintain disinfectant in system for 24 hours.
- F If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.08 SERVICE CONNECTIONS

- A Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B Provide new water service complete with approved double check backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
 - 1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
 - 2. Provide 18 gauge, 0.0478-inch galvanized sheet metal sleeve around service main to 2 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

END OF SECTION 22 1005

**SECTION 22 1006
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Drains.
- B Cleanouts.
- C Hose bibbs.
- D Hydrants.
- E Washing machine outlet boxes.
- F Ice maker outlet boxes.
- G Water hammer arrestors.
- H Sanitary waste interceptors.
- I Mixing valves.

1.02 REFERENCE STANDARDS

- A ASME A112.6.3 - Floor Drains; 2022.
- B ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
- C ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers; 2023.
- D ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems; 2023.
- E ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance; 2023.
- F NSF 61 - Drinking Water System Components - Health Effects; 2024.
- G NSF 372 - Drinking Water System Components - Lead Content; 2024.
- H PDI-WH 201 - Water Hammer Arresters; 2017.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- C Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- D Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.04 QUALITY ASSURANCE

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

1.05 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

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

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2.02 DRAINS

A Manufacturers:

1. Josam Company: www.josam.com/#sle.
2. MIFAB, Inc: www.mifab.com/#sle.
3. Sioux Chief
4. Watts

B Roof Drains:

1. Assembly: ASME A112.6.4.
2. Body: Lacquered cast iron with sump.
3. Strainer: Removable polyethylene dome with vandal proof screws.
4. Accessories: Coordinate with roofing type:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Adjustable under deck clamp.
 - c. Waterproofing flange.
 - d. Adjustable extension sleeve for roof insulation.

C Roof Overflow Drains:

1. Lacquered cast iron body and clamp collar and bottom clamp ring; pipe extended to 2 inches above flood elevation.

D Downspout Nozzles:

1. Bronze round with straight bottom section.

E Floor Drains:

1. Manufacturers:
 - a. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
 - b. MIFAB, Inc; FS1100-C Series: www.mifab.com/#sle.
 - c. Sioux Chief
 - d. Watts
 - e. Zurn Industries, LLC; Z415-BZ1: www.zurn.com/#sle.

F Floor Drain:

1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

G Floor Drain:

1. ASME A112.6.3; lacquered cast iron or stainless steel, two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable square nickel bronze strainer with removable perforated sediment bucket.

H Light-Duty Linear Drains:

1. Body: Channel fabricated from stainless steel, sloped to drain outlet.
2. Clamping flange: Provide clamping flange, clamping collar, or fixed bonding flanges to connect drain to waterproofing membrane. Confirm waterproofing system with Division 07 and Division 09 requirements.

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3. Drain outlet location: Centered side outlet.
 4. Strainer grate: Removable, stainless steel. Provide with vandal-proof screws.
 - a. Finish: As indicated on drawings.
 - b. Grate Pattern: As indicated on drawings.
 5. Linear drain dimensions:
 - a. Strainer width: 3.25 inches.
 - b. Channel length: 26 inches.
 6. Manufacturers:
 - a. Blucher BWC-126 basis of design
- I Prefabricated Trench Drain: Trench drain system assembled from factory fabricated, polymer concrete castings in standard lengths and variable depths, with integral joint flanges and integral grating support rails; includes joint gaskets and grating.
1. Trench Width: 12 inches.
 2. Trench Section Length: 39 inches and 19-1/2 inches.
 3. Grating Support Rail: Stainless steel.
 4. Basis of Design ACO S300K
- J Floor Sink (FS-1):
1. Acid Resistant Lacquered cast iron body with dome strainer and seepage flange.
 2. Top Grate Material: Cast Iron
 3. Top Grate Finish: Acid Resistant enamel or NB as per schedule
 4. Top Shape: Square

2.03 CLEANOUTS

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

2.04 HOSE BIBBS

- A Manufacturers:
1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.

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2. Watts Regulator Company: www.wattsregulator.com/#sle.
3. Woodford
4. Zurn Industries, LLC: www.zurn.com/#sle.

B Interior Hose Bibbs:

1. Basis of Design Woodford Model B24C AND 24C
2. Bronze or brass with mounting flange, replaceable seat, hose thread spout, and integral or add-on vacuum breaker complying with ASSE 1011.
3. Finishes:
 - a. Exposed Locations: Polished chrome.
 - b. Mechanical and Equipment Rooms: Polished chrome or rough bronze.
 - c. Service Areas: Polished chrome.
4. Operation:
 - a. Exposed Locations: Operating key.
 - b. Mechanical and Equipment Rooms: Handwheel, T-handle, or lever.
 - c. Service Areas: Operating key.
5. Provide recessed cover box as noted.

2.05 HYDRANTS

A Manufacturers:

1. Arrowhead Brass & Plumbing, LLC: www.arrowheadbrass.com/#sle.
2. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
3. Zurn Industries, LLC: www.zurn.com/#sle.
4. Watts
5. Woodford

B Wall Hydrants:

1. Basis of Design: Woodford Model 68
2. ASSE 1019, freeze resistant, self-draining, hose thread spout, and integral vacuum breaker.
 - a. Installation: Wall plate.
 - b. Finish: Polished chrome.
 - c. Operation: Operating key.
 - d. Casing and Operating Brass Rod to match wall thickness. Include wall clamp
 - e. Pressure Rating 125 PSIG
 - f. Provide integral lockable cover

2.06 WASHING MACHINE OUTLET BOXES

A Manufacturers:

1. Oatey
2. Zurn Industries, LLC: www.zurn.com/#sle.
3. _____.
4. Guy Grey

- B Description: Plastic preformed rough-in box with brass quarter-turn ball valves or single lever-handle valves, socket for 2 inch waste, and slip-in finishing cover.
- C Provide fire-rated outlet-box assembly for installation in 1- and 2-hour rated walls.
- D Accessories:
 - 1. Water-hammer arrestors.
 - 2. Support brackets for installation between framing studs.

2.07 ICE MAKER OUTLET BOXES

- A Manufacturers:
 - 1. Oatey
 - 2. Zurn Industries, LLC: www.zurn.com/#sle.
- B Description: Plastic preformed square or round rough-in box with brass quarter-turn ball valve, and slip-in finishing cover.
- C Accessories:
 - 1. Water-hammer arrestors.
 - 2. Support brackets for installation between framing studs.

2.08 WATER HAMMER ARRESTORS

- A Manufacturers:
 - 1. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
 - 2. Watts Regulator Company, a part of Watts Water Technologies: www.wattsregulator.com/#sle.
 - 3. Zurn Industries, LLC: www.zurn.com/#sle.
- B Water Hammer Arrestors:
 - 1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.09 SANITARY WASTE INTERCEPTORS

- A Manufacturers:
 - 1. Striem
- B Oil Interceptors: (Parking Garages)
 - 1. Construction
 - 2. Flamible Waste Interceptor
 - a. Model: FWT-35 or FLI 275 as approved by local authority
 - b. Material: Polyethylene
 - c. Rough-in: Fully recessed (shallow rough-in) with anchor flange.
 - d. Holding Capacity: 262 gallons or 35 cubic feet
 - e. Flamible waste capacity: 89 gallons
 - f. Solids capacity: 163 gallons
 - g. Cover: Steel, epoxy coated, non-skid with gasket, securing handle, and enzyme injection port, recessed for floor finish.

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2.10 MIXING VALVES

- A Digitally Controlled Thermostatic Master Mixing Valves:
 - 1. Manufacturers:
 - a. Powers.
 - b. Watts
 - 2. Valve: ASSE 1017, bronze or brass body; corrosion- and lime-resistant internal components; microprocessor-control unit for temperature control and monitoring.
 - 3. Capacity: See Drawings Schedule
 - 4. Mixed-Water Temperature Setting: 120 degrees F.
 - 5. Finish: Rough bronze.
 - 6. Microprocessor Controller:
 - a. Manufacturer-provided, packaged application-specific controller with keypad or touch-screen operator interface.
 - b. Integral display of temperature, pressure, and flow.
 - c. Field Programmable: Settings configurable locally at controller or remotely through building automation system.
 - d. Programmable high-temperature sanitization mode.
 - e. Programmable high- and low-temperature alarms.
 - f. Failsafe: Upon loss of water pressure, valve ceases hot water flow.
 - 7. Electrical Characteristics:
 - a. 120 V, single phase, 60 Hz.
 - 8. Accessories:
 - a. Premounted on unitstrut panel for wall mounting.
 - b. Strainer stop checks on inlets.
 - c. Shut-off valve on inlets and outlet.
 - d. Stem thermometer on outlet.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Encase exterior cleanouts in concrete flush with grade.
- C Install floor cleanouts at elevation to accommodate finished floor.
- D Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to Flush Valves.

END OF SECTION 22 1006

**SECTION 22 1429
SUMP PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Submersible sump pumps.
- B Sump basins and pits.

1.02 REFERENCE STANDARDS

- A ICC (IPC) - International Plumbing Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B UL (DIR) - Online Certifications Directory; Current Edition.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.

1.04 QUALITY ASSURANCE

- A Certifications: UL (DIR) listed, classified, and suitable for the purpose specified and indicated.

1.05 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Manufacturer Warranty: Provide 2-year manufacturer warranty for pumps and related components. Complete forms in Owner's name and register with manufacturer.
- C Submit warranty with related forms completed in Owner's name and registered with manufacturer.

PART 2 PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS

- A Manufacturers:
 - 1. Grundfos Pumps Corporation: www.grundfos.com/#sle.
 - 2. Zoeller Company: www.zoeller.com/#sle
 - 3. Weil
- B General: Cast iron housing and base with oil-filled motor chamber, ball bearings, and mechanical seal.
- C Impeller: Bronze; open nonclog, stainless steel shaft.
- D Motor: Base mount, enclosed, lubricated oil-free, thermal-overload protected, continuous duty, permanent split capacitor with oil-resistant, three-prong connector, 10 foot power cord.
- E Solids Handling Capacity: Pass lint and other small solids up to 1/2 inch in size.
- F Discharge Pipe Size: 2 inch, NPT, female.
- G Maximum Water-Based Effluent Temperature: 120 degrees F.

2.02 SUMP BASINS AND PITS

- A Sump Basin:
 - 1. Basin Volume Holding Capacity: 20 gal Minimum belows the floor level of the pit.
 - 2. Below Ground Pipe Inlet: Molded or predrilled with seal, 4 inch.
 - 3. Basin Dimensions: See Drawing Schedule
 - 4. Basin Material: Polyethylene structural foam, heavy duty injection molded.

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5. Molded-Finish Requirements: Hard bottom, watertight, gas-tight and radon-tight molding.
6. Maximum Effluent Temperature: Match or exceed maximum pump service temperature.
7. Basin Cover:
 - a. Material: One-piece flat lid made of polyethylene with seal gasket.
 - b. Openings: 2" inch discharge and 3-inch vent with hubs.

B Controller

1. Provide single pump controller
 - a. Hand off auto toggle switch
 - b. Green pump run pilot light
 - c. Alarm test and silence switchesRed alarm beacon and audible alarm with (83 to 85) decibel rating for a high water condition
 - d. NEMA 4X watertight enclosure
 - e. Motor protective switch with overload protection
 - f. Magnetic starter
 - g. Numbered terminal strip for connecting pums and variable level float switches.
 - h. Integral auxiliary terminal board connections (dry contact) for remote alarm devices
2. Provide Duplex pump controller
 - a. Hand off auto toggle switch
 - b. Green pump run pilot light
 - c. Alarm test and silence switchesRed alarm beacon and audible alarm with (83 to 85) decibel rating for a high water condition
 - d. NEMA 4X watertight enclosure
 - e. Motor protective switch with overload protection
 - f. Magnetic starter for each pump
 - g. Alternating mechanism
 - h. Numbered terminal strip for connecting pumps and variable level float switches.
 - i. Integral auxiliary terminal board connections (dry contact) for remote alarm devices
 - j. Dry contacts for BAS integration

PART 3 EXECUTION

3.01 INSTALLATION

- A Install products with related fittings and accessories according to manufacturer instructions.
- B Observe and provide incidentals required to complete installation in compliance with ICC (IPC).

3.02 FIELD QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.
- B Operational Tests: Conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

END OF SECTION 22 1429

**SECTION 22 3000
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Commercial gas-fired water heaters.
- B Commercial electric water heaters.
- C Packaged water heating systems.
- D Domestic hot water storage tanks.
- E Diaphragm-type compression tanks.
- F Acid-effluent neutralizers.
- G In-line circulator pumps.
- H Domestic Hot Water Recirculation Valves

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023, with Errata (2024).

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittals procedures.
- B Product Data:
 - 1. Product Data: Provide manufacturer's literature and data sheets for each product. Include information on materials of fabrication, assembly of components, dimensions, weights, capabilities, performance, electrical characteristics, location and sizes of connections, service and access locations, and manufacturer-provided and field-installed accessories.
- C Shop Drawings:
 - 1. Provide plans and elevations showing equipment assembly, including fabrication and installation details. Show location and sizes of connections.
 - 2. Indicate clearances required for service, access, maintenance, and replacement of internal components.
- D Manufacturer's Instructions: Indicate installation instructions.
- E Operation and Maintenance Data: Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.
- F Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A Certifications:
 - 1. Water Heaters: NSF approved.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Manufacturer Warranty: Provide 15 year manufacturer warranty for commercial gas fired water heaters. Complete forms in Owner's name and register with manufacturer.
- C Manufacturer Warranty: Provide 5-year manufacturer warranty for domestic water heaters and water storage tanks. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS**2.01 WATER HEATERS**

- A Manufacturers:
1. A.O. Smith Water Products Co: www.hotwater.com/#sle.
 2. Bock Water Heaters, Inc: www.bockwaterheaters.com/#sle.
 3. Bradford White Corporation: www.bradfordwhite.com/#sle.
 4. Hubbell
 5. Lochinvar
 6. PVI
 7. Rheem Manufacturing Company: www.rheem.com/#sle.
 8. State Water Heaters
- B Commercial Gas-Fired Water Heaters:
1. Manufacturers:
 - a. PVI Conquest: Basis of Design for Aquaplex Tanks
 - b. Hubble: GSE Basis of Design for Cement Lined Tanks
 - c. AO Smith BTH - Basis of Design for glass lined Tanks
 2. Type: Automatic, natural gas-fired, vertical storage.
 3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
 4. Performance: See Drawing Schedule
 5. **AquaPlex Tank:** combustion chamber and fire tubes will be constructed from phase-balanced austenitic and ferritic duplex steel with a chemical structure containing a minimum of 21% chromium to prevent corrosion and mill certified per ASTM A 923 Methods A to ensure that the product is free of detrimental chemical precipitation that affects corrosion resistance. The material selected shall be tested and certified to pass stress chloride cracking test protocols as defined in ISO 3651-2 and ASTM G123 - 00(2005) "Standard Test Method for Evaluating Stress-Corrosion Cracking of Stainless Alloys with Different Nickel Content in Boiling Acidified Sodium Chloride Solution." All internal and external tank surfaces shall undergo full immersion passivation and pickling processing to meet critical temperature, duration and chemical concentration controls required to complete corrosion resistance restoration of pressure vessel surfaces. Other passivation and pickling methods are not accepted. Immersion passivation and pickling certification documents are required and shall be provided with each product.

6. **Glass Line Tank:** Glass-lined, welded steel, ASME labeled; multiple flue passages, 4-inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
 7. **Cement Lined Tank:** HydraStone Cement Lined welded steel, ASME labeled; multiple flue passages, 4-inch diameter inspection port, thermally insulated with minimum 2 inches glass fiber, encased in corrosion-resistant steel jacket; baked-on enamel finish; floor shield and legs.
 8. **Burner:** Combustion will be provided by a premix, fan-assisted surface burner with a gas train meeting UL, ANSI and FM standards for the input specified.
 9. **Gas Train:** Gas train components will capable of self-proportionating gas and air to maintain optimum combustion in response to varying vent pressures
 10. Water heater will be a category IV, condensing appliance and vent through Polypropylene, or A29 stainless steel. Water heater will satisfy requirements for sealed combustion. Vents for inlet air and exhaust can terminate in different pressure zones. Concetric Vent kits not allowed.
 11. Intake Air piping shall be Polypropylene or PVC.
 12. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.
 - d. Anode: Magnesium on non PVI Water and Hubbel Heaters
 - e. Temperature and Pressure Relief Valve: ASME labeled.
 - f. Provide Dielectric connection as per manufacturer requirements.
 - g. Provide Acit Neutralization Kit
 13. Applications:
 - a. Automatic storage water heater.
 - b. Automatic circulating tank water heater.
 - c. For operation on combustible floors.
 14. **Controls:** Automatic water thermostat with temperature range adjustable from 120 to 180 degrees F, automatic reset high temperature limiting thermostat factory set at 195 degrees F, gas pressure regulator, multi-ribbon or tubular burner, 100 percent safety shut-off pilot and thermocouple, flue baffle and draft hood.
- C Commercial Electric Water Heaters: - Polybutene Tank
1. Manufacturers:
 - a. Rheem Marathon
 2. Type: Factory-assembled and wired, electric, vertical storage.
 3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
 4. Performance: See Drawing Schedule
 5. Seamless, blow-molded, polybutene tank impervious to rust and corrosion.
 6. Pex dip tube

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7. Tough molded polyethylene outer shell resist dents, scratches and salt air corrosion.
 8. Polyurethane Insulation
 9. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
 10. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Crosslink polyethylene (PEX).
 - c. Drain valve.
 - d. Anode: Not Required
 - e. Temperature and Pressure Relief Valve: ASME labeled.
 11. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.
- D Commercial Electric Water Heaters - Cement Lined
1. Manufacturers:
 - a. Hubbell E and SE Series
 2. Type: Factory-assembled and wired, electric, vertical storage.
 3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
 4. Performance: See Drawing Schedule
 5. Controls: Automatic immersion water thermostat; externally adjustable temperature range from , flanged or screw-in nichrome elements, high temperature limit thermostat.
 6. Tank: Welded steel ASME labeled pressure vessel; cement lining, mounted on steel channel base with lifting lugs, insulated with 2 inch polyurethane; enclosed in a high impact colorized composite jacket.
 7. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.
 8. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.
 - d. Temperature and Pressure Relief Valve: ASME labeled.
- E Commercial Electric Water Heaters: Glass Lined
1. Manufacturers:
 - a. AO Smith
 - b. Bradford White Corporation; ElectriFLEX Series: www.bradfordwhite.com/#sle.
 - c. Rheem
 - d. State
 2. Type: Factory-assembled and wired, electric, vertical storage.
 3. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.
 4. Performance: See Drawing Schedule

5. Electrical Characteristics:
6. Tank: Glass lined welded steel; 4 inch diameter inspection port, thermally insulated with minimum 2 inches polyurethane encased in corrosion-resistant steel jacket; baked-on enamel finish.
7. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in nichrome elements, high temperature limit thermostat.
8. Accessories:
 - a. Water Connections: Brass.
 - b. Dip Tube: Brass.
 - c. Drain valve.
 - d. Anode: Magnesium.
 - e. Temperature and Pressure Relief Valve: ASME labeled.
9. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.

2.02 BOILERS

- A Manufacturers:
 1. Hubbell NX Series
 2. Lochinvar Shield
- B System: Gas-fired water tube, direct heating boiler, circulating pump, controls, piping and valving as indicated, storage tank.
 1. Heat Exchanger
 - a. Stainless Steel with minimum turndown of 5 to 1
 2. Vertical storage tank: See Drawings Schedule for Sizing
 - a. Working Pressure: 150 psi ASME labeled.
 - b. Epoxy and Glass Lined Tank Lining: 15 mil thick epoxy lining extended through flanges and couplings.
 - c. Cement Lined Tanks: 1/2" thick Hydrastone Cement lined steel tank
 - d. Insulation: 3-inch Rigid foam or glass fiber insulation with steel jacket.
 3. Pump:
 - a. Type: All bronze, in-line circulation pump mounted on boiler, controlled by tank-mounted immersion thermostat.
 - b. Thermostat Setpoint: 140 degrees F.
 - c. Electrical Characteristics: See Drawing Schedule
 - d. Accessories
 - 1) Venting Material Shall be Polypropylene or Stainless Steel (PVC not allowed).
 - 2) Condensate Neutralization Kit

2.03 DOMESTIC HOT WATER STORAGE TANKS

- A Tank: Welded steel, ASME labeled for working pressure of 125 psig, steel support saddles, tappings for accessories, threaded connections of stainless steel, access manhole.

- B Insulation: 2 inch thick, non-cfc foam on respective top and tank sides.
- C Openings: Up to 3 inches, copper-silicone threaded; over 4 inches, flanged; flanged collar for heat exchanger; manway fitting.
- D Accessories: Provide drain valve, hot water isolation valve, pressure-temperature (PT) relief valve ASME rated for maximum working pressure, and thermometer with range of 40 to 200 degrees F.

2.04 DIAPHRAGM-TYPE COMPRESSION TANKS

- A Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.
- C Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psig.
- D Size
 - 1. Provide the following sizes for each water heater tanks unless noted otherwise.
 - a. Systems with water heaters less than 60 gallons. Provide Amtrol ST-5
 - b. System with water heater tanks greater or equal to 60 gallons provide ST-12

2.05 ACID-EFFLUENT NEUTRALIZERS

- A Basis of Design: Axiom NC-1 or equal
- B Performance:
 - 1. Maximum Low pH Water Flow Rate: 1.6 gpm.
 - 2. Media consists of limestone mineral media.
- C Mineral Tank: Glass fiber reinforced tank.
 - 1. Size: 4 inches diameter, 13 inches.
 - 2. Weight: 4.5 lbs

2.06 IN-LINE CIRCULATOR PUMPS

- A Manufacturers:
 - 1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - 3. Taco
- B Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
- C Impeller: Bronze.
- D Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- E Seal: Carbon rotating against a stationary ceramic seat.
- F Drive: Flexible coupling.

2.07 DOMESTIC HOT WATER RECIRCULATION VALVES

- A Manufacturers:
 - 1. Therm-Omega- Tech

- a. Circuit Solver Model - CUAS (Verify Temperature and size prior to ordering).
- b. Provide thermometer on end circuit solvers only.
- B Furnish and install as indicated on the plans, a thermostatically controlled recirculation valve (TRV) in the domestic hot water piping. TRV shall be self contained and fully automatic without additional piping or control mechanisms. Valve shall be a Circuit Solver™ TRV as manufactured by Therm-Omega-Tech, Inc., or equivalent.
- C TRV shall regulate the flow of recirculated domestic hot water based on water temperature entering the TRV regardless of system operating pressure.
- D When fully closed the TRV shall bypass a minimum of 0.1 GPM hot water to maintain dynamic control of the recirculating loop.
- E TRV shall be factory adjustable from 105 F (40.5 C) to 140 F (60 C) as required by project conditions.
- F Fully open TRV shall modulate towards a minimum closed position upon sensing a water temperature above 3 F of set point.
- G TRV shall be available in sizes ranging from ½ inch NPT to 2" NPT.
- H TRV body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel.
- I TRV sizes ½ inch through 2 inch shall be rated to 200 PSIG maximum working pressure.
- J All TRV shall be standard tapered female thread, NPT.
- K All TRV shall be rated to 300 F (148.9 C) maximum working temperature.
- L TRV shall be ANSI/AWWA C800 compliant.
- M All TRV shall be NSF-61 certified for use in all domestic water systems.
- N The TRV will come complete with union, strainer, isolation ball valves, check valve and thermometer. The unit will come completely assembled from the factory.
- O Thermal actuator shall be spring operated and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits.
- P Thermal actuator shall be rated for a minimum of 200,000 cycles.
- Q Installation of TRV shall be made by qualified tradesmen. Install TRV in each domestic hot water return piping branch beyond last hot water device in that branch.
- R Assembly shall provide suitable line size isolation valves, unions, and strainer as indicated in piping detail shown on the drawings. Provide integral thermometer for reading recirculated water temperature.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.
- B Coordinate system, equipment, and piping work with applicable electrical, fuel, gas, vent, drain, and waste support interconnections as included or provided by other trades.
- C Domestic Hot Water Storage Tanks:
 - 1. Provide steel pipe support, independent of building structural framing members.
 - 2. Clean and flush prior to delivery to site. Seal until pipe connections are made.

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D Pumps:

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

3.02 FIELD QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.

3.03 SCHEDULES - SEE DRAWINGS

END OF SECTION 22 3000

**SECTION 22 4000
PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Flush valve water closets.
- B Wall hung urinals.
- C Lavatories.
- D Sinks.
- E Under-lavatory pipe supply covers.
- F Plunge Pool
- G Showers.
- H Electric water coolers.
- I Bi-level, electric water coolers.
- J Mop sinks.
- K Service sinks.
- L Emergency eye and face wash.
- M Emergency showers.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008 (Reaffirmed 2013).
- C ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- D ASME A112.18.1 - Plumbing Supply Fittings; 2018, with Errata.
- E ASME A112.18.9 - Protectors/Insulators for Exposed Waste and Supplies on Accessible Fixtures; 2011 (Reaffirmed 2022).
- F ASME A112.19.2 - Ceramic Plumbing Fixtures; 2018, with Errata.
- G ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
- H ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
- I ASSE 1014 - Performance Requirements for Backflow Prevention Devices for Hand-Held Showers; 2020.
- J ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices; 2020.
- K ASTM C1822 - Standard Specification for Insulating Covers on Accessible Lavatory Piping; 2021.
- L ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- M NSF 61 - Drinking Water System Components - Health Effects; 2024.
- N NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.

- B Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C Manufacturer's Instructions: Indicate installation methods and procedures.
- D Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- E Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- F Subject to BABAA compliance requirements. All products shall match basis of design quality and performance. Any product substitutions shall be provided with full BABBA compliance documentation.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A Accept fixtures on-site in factory packaging. Inspect for damage.
- B Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.07 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS**2.01 GENERAL REQUIREMENTS**

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

2.02 REGULATORY REQUIREMENTS

- A Comply with applicable codes for installation of plumbing systems.
- B Perform work in accordance with local health department regulations.

2.03 FLUSH VALVE WATER CLOSETS

- A Water Closets:
 - 1. Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, china bolt caps.
 - 2. Bowl: ASME A112.19.2; 16.5 inches high with elongated rim.
 - 3. Flush Valve: Exposed (top spud).
 - 4. Flush Operation: Manual, oscillating handle.
 - 5. Handle Height: 44 inches or less.
 - 6. Inlet Size: 1-1/2 inches.
 - 7. Trapway Outlet: 4 inch.
 - 8. Color: White.
 - 9. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com/#sle.
 - b. Kohler Company:
 - c. Zurn Industries, LLC:.

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d. Substitutions: See Section 01 6000 - Product Requirements.

B Flush Valves:

1. Valve Supply Size: 1 inch.
2. Valve Outlet Size: 1-1/2 inches.
3. Manufacturers:
 - a. Sloan Valve Company: Sensor Operated (Battery/AC) G2 8111
 - b. Zurn Industries, LLC:
 - c. Hyrdotek - 8000 Series (Sensor Battery/AC)
4. Sensor-Operated: (Battery Powered)
 - a. Type: ASME A112.19.5; chloramine-resistant clog-resistant dual-seat diaphragm valve or solenoid powered piston valve complete with vacuum breaker, stops and accessories.
 - b. Mechanism: Solenoid-operated piston or electronic motor-actuated operator with battery powered infrared sensor, and mechanical override or override push button.
 - c. Supplied Volume Capacity: 1.6 gal per flush.
 - d. Exposed Type: Chrome-plated, escutcheon, integral screwdriver stop.
 - e. Metering Type: Easily accessible adjustment nut.

C Toilet Seats:

1. Manufacturers:
 - a. American Standard, Inc:
 - b. Bemis Manufacturing Company
 - c. Centoco
 - d. Church Seat Company:
 - e. Olsonite:
 - f. Zurn Industries, LLC:
 - g. Substitutions: See Section 01 6000 - Product Requirements.
2. Plastic: Solid, white finish, elongated shape, open front, slow-closing hinged seat cover, and brass bolts with covers.
3. Plastic: Black finish, open front, extended back, self-sustaining hinge, brass bolts, with cover.

D Water Closet Carriers:

1. Manufacturers:
 - a. Jay R. Smith Manufacturing Company:
 - b. JOSAM Company:
 - c. Watts
 - d. Zurn Industries, LLC:
2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.04 WALL HUNG URINALS

A Manufacturers:

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1. American Standard, Inc: www.americanstandard-us.com/#sle.
 2. Kohler Company: www.kohler.com/#sle.
 3. Zurn Industries, LLC: www.zurn.com/#sle.
 4. Subject to BABAA compliance requirements. All products shall match basis of design quality and performance. Any product substitutions shall be provided with full BABBA compliance documentation.
- B Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Consumption Volume: 1.0 gal per flush, maximum.
 2. Flush Style: Washout.
 3. Flush Valve: Exposed (top spud).
 4. Flush Operation: Sensor operated.
 5. Trapway Outlet: Integral.
 6. Removable stainless steel strainer.
 7. Supply Size: 3/4 inch.
 8. Outlet Size and Location: 2 inches, bottom side.
- C Flush Valves:
1. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com/#sle.
 - b. Hydrotek HX-8000XX Series
 - c. Sloan Valve Company: www.sloanvalve.com/#sle. Sloan G2 8186
 - d. Zurn Industries, LLC; ZEMS Series: www.zurn.com/#sle.
 - e. _____.
 2. Sensor-Operated: Battery Operated
 - a. Type: ASME A112.19.5; chloramine-resistant, clog-resistant dual-seat diaphragm valve or solenoid-actuated piston valve with vacuum breaker, stops and accessories.
 - b. Mechanism: Solenoid-operated piston or electronic motor-actuated operator with low-voltage powered infrared sensor, and mechanical override or override push button.
 - c. Supplied Volume Capacity: 1.0 gal per flush.
 - d. Exposed Type: Chrome-plated, escutcheon, integral screwdriver stop.
 - e. Metering Type: Easily accessible adjustment nut.
- D Urinal Carriers:
1. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.05 LAVATORIES

- A Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com/#sle.
 2. Kohler Company: www.kohler.com/#sle.
- B Wall-Hung Basin:

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1. Vitreous China: ASME A112.19.2; white, rectangular basin with splash lip, front overflow, soap depression, and hanger. Size as indicated on drawings with 4-inch centerset spacing or single hole to match faucet.
 2. Carrier:
 - a. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, bearing plate and studs.
 - b. Manufacturers:
 - 1) Jay R. Smith MFG. Co: www.jrsmith.com/#sle.
 - 2) JOSAM Company: www.josam.com/#sle.
 - 3) Zurn Industries, LLC; Z1231: www.zurn.com/#sle.
- C Supply Faucet:
1. Deck Mounted Faucet Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com/#sle.
 - b. Chicago
 - c. Hydrotek
 - d. Kohler Company: www.kohler.com/#sle.
 - e. Sloan EAF-275 Series is basis of design
 2. ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with maximum flow of 2.2 gpm, indexed handles.
- D Sensor Operated Faucet:
1. Cast brass, chrome plated, deck mounted with sensor located on neck of spout. Serviceable above deck.
 2. Spout Style: Standard.
 3. Power Supply:
 - a. Wireless:
 - 1) Battery: Replaceable alkaline or lithium type with 200,000 cycles, minimum.
 - 2) Light Cell: Photovoltaic or infra-red cell that transforms both sunlight and artificial light into electrical energy for use and battery charging.
 - 3) Low Battery Warning: Provide red or yellow colored indicator to light periodically at 30 days of remaining capacity and continuously 2 weeks prior to get fully discharged.
 4. Mixing Valve: External lever operated.
 5. Water Supply: 3/8 inch compression connections.
 6. Aerator: Vandal resistant, 0.5 gpm, laminar flow device.
 7. Automatic Shut-off: 30 seconds.
 8. Sensor Range: Factory set at 3 inch adjustable up to 24 inch.
 9. Sensor Range: Automatically adjusts.
 10. Finish: Polished chrome.
 11. Lead Content: Extra low; maximum 0.25 percent by weighed average.
- E Sensor Operated Faucet: (Undercounter 1070)

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1. Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
Serviceable above deck.
 2. Power Supply:
 - a. Wireless:
 - 1) Battery: Replaceable alkaline or lithium type with 200,000 cycles, minimum.
 - 2) Light Cell: Photovoltaic or infra-red cell that transforms both sunlight and artificial light into electrical energy for use and battery charging.
 3. Automatic Shut-off: 30 seconds.
 4. Sensor Range: Factory set at 3 inch adjustable up to 24 inch.
 5. Sensor Range: Automatically adjusts.
 6. Accessory: Provide 1070 Mixing Valve
 7. Lead Content: Extra low; maximum 0.25 percent by weighed average.
- F Thermostatic Mixing Valve:
1. ASSE 1070 listed with combination stop, strainer, and check valves, and flexible stainless steel connectors.
- G Accessories:
1. Chrome plated 17 gauge, 0.0538 inch brass P-trap and arm with escutcheon.
 2. Offset waste with perforated open strainer.
 3. Combination stop and strainer.
 4. Screwdriver stops.
 5. Rigid supplies.

2.06 SINKS

- A Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com/#sle.
 2. Jay R. Smith Manufacturing Company: www.jrsmith.com/#sle.
 3. Kohler Company: www.kohler.com/#sle.
 4. Just / Elkay.
- B Single Compartment Bowl
1. ASME A112.19.3; See Drawing schedules for size outside dimensions, 18 gauge, 0.050 inch thick, type 304 stainless steel, self-rimming and undercoated, with back edge drilled for trim.
 2. Drain: 3-1/2 inch crumb cup and tailpiece.
- C Kitchen Faucets:
1. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com/#sle.
 - b. Chicago
 - c. Delta
 - d. Elkay.
 2. Single Handle Faucet:
 - a. Type: Deck-mount, high-arc, swivel faucet with mounting plate.

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- b. Spray Type: Full stream spray at 1.5 gpm, maximum.
- c. ASME A112.18.1, ADA Standards, and NSF 61 compliant assembly.
- d. Materials: Ceramic disc-cartridge valve on brass body with polished chrome finish.
- D Accessories: Provide braided water supply lines, slip-joint p-trap, stainless steel basket strainer, and ASSE 107 Mixing valve where required..

2.07 UNDER-LAVATORY PIPE SUPPLY COVERS

- A Manufacturers:
 - 1. Plumberex Specialty Products, Inc: www.plumberex.com/#sle.
- B Basis of Design: Plumberex Specialty Products, Inc; www.plumberex.com/#sle.
 - 1. Under-Lavatory Covers with Snap-Lock Fasteners (Molded): Plumberex Pro-Extreme.
- C General:
 - 1. Insulate exposed drainage piping including hot, cold and tempered water supplies under lavatories or sinks per ADA Standards.
 - 2. Construction: 1/8 inch PVC with antimicrobial, antifungal and UV resistant properties.
 - a. Comply with ASTM C1822 Type III for covers on accessible lavatory piping.
 - b. Comply with ASME A112.18.9 for covers on accessible lavatory piping.
 - c. Comply with ICC A117.1.
 - 3. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.
No cable ties allowed.

2.08 PLUNG POOL

- A Manufacturer
 - 1. Whitehall Manufacturing WHS-110-S
- B Whirlpool Tank is 56”L x 24”W x 25”D and is seamless welded construction, fabricated from heavy gauge, type 304 stainless steel, polished to a satin finish. Tank rom is reinforced with a conealed stainless steel rod.
- C Tank Bottom is seamless, coved design for effective cleaning.
- D Provide turbing raising and lowering device which permits height adjustment and dirction of water agitation.
- E Turbine assembly is UL listed with 1/2 HP jet pump.

2.09 SHOWERS

- A Shower Trim:
 - 1. Single Handle: ASME A112.18.1; lever-handle operated, pressure balanced mixing valve with integral service stops, bent shower arm with adjustable spray ball joint shower head with maximum flow, and escutcheon.
- B Shower Valve:
 - 1. Comply with ASME A112.18.1.
 - 2. Provide two-handle, in-wall diverter valve body with integral thermostatic mixing valve to supply 1.5 gpm.
- C Shower Head:

1. ASME A112.18.1; chrome-plated vandal-proof institutional head with integral wall bracket, built-in 2.5 gpm flow control.

D Hand-Held Shower Head:

1. ASME A112.18.1, adjustable spray hand-held shower head with swivel fitting with ASSE 1014 backflow preventer.
2. Provide pushbutton flow control.
3. Include 60 inch minimum flexible polished stainless steel hose and in-line vacuum breaker
4. Provide 25 inch grab bar with sliding spray holder that locks at any height, allowing use of unit as either a hand-held spray or a fixed shower head.

2.10 ELECTRIC WATER COOLERS

A Manufacturers:

1. Elkay Manufacturing Company: www.elkay.com/#sle.
2. Haws Corporation: www.hawsco.com/#sle.
3. Oasis International: www.oasiscoolers.com/#sle.

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

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

C Bottle Filler: Materials to match fountain.

2.11 BI-LEVEL, ELECTRIC WATER COOLERS

A Manufacturers:

1. Elkay Manufacturing Company: www.elkay.com/#sle.
2. Haws Corporation: www.hawsco.com/#sle.
3. Murdock Manufacturing, Inc: www.murdockmfg.com/#sle.
4. Oasis International: www.oasiscoolers.com/#sle.

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

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

C Bottle Filler: Materials to match fountain.

2.12 MOP SINKS

A Molded Stone Mop Sink Manufacturers:

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1. Manufacturers
 - a. Acorn Engineering Company: www.acorneng.com/#sle.
 - b. Fiat - MSB2424
2. Material: Molded Stone composed of
3. Type: Rectilinear, standard height.
4. Tiling Flange Construction: Galvanized steel.
5. Grid strainer: Stainless steel; integral; removable.
6. Dimensions: As indicated on drawings.
7. Accessories:
 - a. 3 feet of 1/2 inch diameter plain end reinforced rubber hose.
 - b. Hose and Hose clamp hanger. 832AA
 - c. Mop hanger. 889CC
 - d. Chicago 540-LD897SWXFABC commercial faucet with pail hook and wall bracket.
 - e. Sealed to wall
 - f. Provide SS Wall Backing 12" past in each direction up to 4 feet.

2.13 SERVICE SINKS

- A Manufacturers:
1. FIAT.
- B Bowl Fiat FL1: 20 by 24 by 34 inches high, white molded stone, floor mounted, with 1-inch wide shoulders, vinyl bumper guard, stainless steel strainer. bowl depth of 14"
- C Two-Lever Handle Service Faucet:
1. Type: Deck-mount spout faucet with union inlets and mounting plate.
 2. Spray Type: Full stream spray at 1.8 gpm, maximum.
 3. ASME A112.18.1, ADA Standards, and NSF 61 compliant assembly.
 4. Materials: Ceramic disc cartridge valve on brass body with polished chrome finish.
 5. Products:
 - a. Chicago. 891
 - b. Fiat
- D Accessories:
1. P-trap

2.14 EMERGENCY EYE AND FACE WASH

- A Manufacturers:
1. Haws Corporation: www.hawsco.com/#sle.
 2. Bradley
 3. Stingray.
- B Emergency Wash: ANSI Z358.1; wall-mounted, self-cleaning, nonclogging eye and face wash with quick opening, full-flow valves, stainless steel eye and face wash receptor, twin eye wash heads and face spray ring, stainless steel dust cover, copper alloy control valve and fittings.
- C Regulated flow of 3gpm measured at 30 psi.

D Integral Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.

E Integral Thermometer

2.15 EMERGENCY SHOWERS

A Manufacturers:

1. Haws Corporation: www.hawsco.com/#sle.
2. Therm-Omega-Tech, Inc: www.thermomegatech.com/#sle.
3. Bradley
4. Stingray.

B Emergency Shower: ANSI Z358.1; wall-mounted, self- cleaning, nonclogging 8 inch diameter stainless steel deluge shower head with elbow, one inch full flow valve with pull chain and 8 inch diameter ring, one inch interconnecting fittings.

C Integral Thermostatic Mixing Valve: Thermostatic mixing valve, ASSE 1070 listed, with combination stop, strainer, and check valves, and flexible stainless steel connectors.

D Integral Thermometer

PART 3 EXECUTION

3.01 EXAMINATION

A Verify that walls and floor finishes are prepared and ready for installation of fixtures.

3.02 PREPARATION

A Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

A Install each fixture with trap, easily removable for servicing and cleaning.

B Provide chrome-plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

C Install components level and plumb.

D Install and secure fixtures in place with wall supports and bolts.

E Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

A Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

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

3.06 CLEANING

A Clean plumbing fixtures and equipment.

3.07 PROTECTION

A Protect installed products from damage due to subsequent construction operations.

B Do not permit use of fixtures by construction personnel.

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

3.08 SCHEDULES

A Fixture Rough-In

1. Water Closet (Flush Valve Type):
 - a. Cold Water: 1 Inch.
 - b. Waste: 4 Inch.
 - c. Vent: 2 Inch.
2. Urinal (Flush Valve Type):
 - a. Cold Water: 3/4 Inch.
 - b. Waste: 2 Inch.
 - c. Vent: 1-1/2 Inch.
3. Lavatory:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 - d. Vent: 1-1/4 Inch.
4. Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 - d. Vent: 1-1/4 Inch.
5. Service Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 3 Inch.
 - d. Vent: 1-1/2 Inch.
6. Drinking Fountain:
 - a. Cold Water: 1/2 Inch.
 - b. Waste: 1-1/4 Inch.
 - c. Vent: 1-1/4 Inch.

END OF SECTION 22 4000

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**SECTION 23 0500
BASIC HVAC REQUIREMENTS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced in the specification sections throughout the project manual.

1.02 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.
- F The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene monomer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.
- G Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - 1. Any item listed as furnished shall also be installed, unless otherwise noted.
 - 2. Any item listed as installed shall also be furnished, unless otherwise noted.

1.03 QUALITY ASSURANCE

- A Contractor's Responsibility Prior to Submitting Pricing Data:
 - 1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
 - 2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's

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own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

B Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

C Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, any parts of the drawings or specifications that do not comply with the codes or regulations, he shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, he shall submit with his proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.

D Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. It is the sole responsibility of the contractor to obtain and procure permits. The Engineer is not liable for any costs associated with the cost of permits or delays associated with permitting or obtaining permits under this division. The engineer at times may submit the permit in advance to help with project timeline. However, this fact does not relieve the installing contractor(s) from tracking and ensuring permitting process is being completed.
4. Pay all charges for permits or licenses.
5. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
6. Pay all charges arising out of required inspections by an authorized body.
7. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
8. Where applicable, all fixtures, equipment and materials shall be approved or listed by Underwriter's Laboratories, Inc.

E Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.

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3. Make application for and pay for service connections, such as gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
 - a. Any item listed as furnished shall also be installed, unless otherwise noted.
 - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit or Cadd platforms
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by Engineer.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.

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5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by Engineer for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by Engineer as to the accuracy or correctness of the information provided. Engineer accepts no responsibility or liability for the Contractor's use of these documents.
9. Electrical Characteristics for 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.

1.04 SUBMITTALS

- A Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.
- B General Submittal Procedures: The following are required:
 1. Transmittal: Each transmittal shall include the following:
 - a. Date
 - b. Project title and number
 - c. Contractor's name and address
 - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - e. Description of items submitted and relevant specification number
 - f. Notations of deviations from the contract documents
 - g. Other pertinent data
 2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
 - a. Date
 - b. Project title and number
 - c. Architect/Engineer
 - d. Contractor and subcontractors' names and addresses
 - e. Supplier and manufacturer's names and addresses
 - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
 - g. Description of item submitted (using project nomenclature) and relevant specification number
 - h. Notations of deviations from the contract documents
 - i. Other pertinent data
 - j. Provide space for Contractor's review stamps

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3. Composition:
 - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
 - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
 - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
 - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
 - b. Unstamped submittals will be rejected.
 - c. The Contractor's review shall include, but not be limited to, verification of the following:
 - 1) Only approved manufacturers are used.
 - 2) Addenda items have been incorporated.
 - 3) Catalog numbers and options match those specified.
 - 4) Performance data matches that specified.
 - 5) Electrical characteristics and loads match those specified.
 - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
 - 7) Dimensions and service clearances are suitable for the intended location.
 - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
 - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
 - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
 - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract

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documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.

6. Submittal Identification and Markings:

- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
- b. The Contractor shall clearly indicate the size, finish, material, etc.
- c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
- d. All marks and identifications on the submittals shall be unambiguous.

7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.

9. Reproduction of contract documents alone is not acceptable for submittals.

10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.

11. Submittals not required by the contract documents may be returned without review.

12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.

13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.

14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. Submittal file name: 2025-081SD 23 XX XX description.pdf
5. File Size: Electronic file size shall be limited to a maximum of 10MB. Larger files shall be transmitted via a pre-approved method.

1.05 CHANGE ORDERS

- A A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B Change order work shall not proceed until authorized.

1.06 EQUIPMENT SUPPLIERS' INSPECTION

- A The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
 - 1. Base Mounted Pumps
 - 2. Boilers, Burners and Boiler Trim
 - 3. Water Chillers, Fluid Coolers, Central Heat Pumps
- B Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.07 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B Coordinate the installation of heavy and large equipment with the Construction Manager or General Contractor. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- C Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate his/her work with other trades.

1.08 WARRANTY

- A Provide 24 month warranty, unless otherwise noted, to the owner for all pumps, boilers, controllers, chillers, condensing units to ensure units have gone through entire cycle of seasons.
- B The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.

1.09 MATERIAL SUBSTITUTION

- A Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality required.
- B Equivalent equipment manufactured by the other named manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications, and fits in the allocated space.
- C Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer not later than ten days prior to the bid opening.
- D This Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on his part or on the part of other Contractors whose work is affected.
- E This Contractor may list voluntary add or deduct prices for alternate materials on the bid form. These items will not be used in determining the low bidder.
- F All material substitutions requested later than ten (10) days prior to bid opening must be listed as voluntary changes on the bid form.

PART 2 PRODUCTS**2.01 NOT APPLICABLE****PART 3 EXECUTION****3.01 JOBSITE SAFETY**

- A Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or his or her employee and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and his or her personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

3.02 PROJECT CLOSEOUT

- A The following paragraphs supplement the requirements of Division 1.
- B Final Jobsite Observation:
 - 1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
 - 2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.

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3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
 4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C Before final payment is authorized, this Contractor must submit the following:
1. Operation and maintenance manuals with copies of approved shop drawings.
 2. Record documents including marked-up or reproducible drawings and specifications.
 3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
 4. Inspection by State Boiler Inspector.
 5. Start-up reports on all equipment requiring a factory installation inspection or start-up.
 6. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed; receipt by Architect/Engineer required prior to final payment approval.

3.03 OPERATION AND MAINTENANCE MANUALS

- A General:
1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
 2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.
- B Electronic Submittal Procedures:
1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
 - a. O&M file name: O&M.div23.contractor.YYYYMMDD

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5. File Size: Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
6. Provide the Owner with an approved copy of the O&M manual in digital format which is tabbed and bookmarked accordingly.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.

3.04 SYSTEM COMMISSIONING

- A The mechanical systems shall be complete and operating. System start-up, testing, balancing, and satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 50% RH.

- C Contractor shall adjust the mechanical systems and controls at season changes during the one 2 year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

3.05 RECORD DOCUMENTS

- A The following paragraph supplements Division 1 requirements:
 - 1. Contractor shall maintain at the job site a separate and complete set of mechanical drawings and specifications on which he shall clearly and permanently mark in complete detail all changes made to the mechanical systems.
- B Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other
 - 1. units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- C Refer to Section 23 09 00 for additional requirements for Temperature Control documents.
- D Before completion of the project, a set of reproducible mechanical drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

3.06 ADJUST AND CLEAN

- A Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.

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- B Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C Remove all rubbish, debris, etc., accumulated during construction from the premises.

END OF SECTION 23 0500

SECTION 23 0516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- B EJMA (STDS) - EJMA Standards; Eleventh Edition.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- C Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
- D Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A Manufacturers:
 - 1. The Metraflex Company: www.metraflex.com/#sle.
- B Inner Hose: Bronze.
- C Exterior Sleeve: Single braided, stainless steel.
- D Pressure Rating: 125 psi up to 12 inch.
- E Maximum Service Temperature: 450 degrees F.
- F End Connections: Flanged.
- G Size: Use pipe sized units.
- H Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A Manufacturers:
 - 1. The Metraflex Company: www.metraflex.com/#sle.
- B Inner Hose: Bronze.
- C Exterior Sleeve: Braided bronze.
- D Maximum Service Temperature: 450 degrees F.

- E End Connections: Flanged.
- F Size: Use pipe sized units.
- G Maximum offset: 3/4 inch on each side of installed center line.
- H Application: Copper piping.

2.03 EXPANSION JOINTS - METAL BELLOWS TYPE

- A Provide shroud to protect from external damage and allows for the application of external insulation.
- B Pressure Rating: 125 psi and 400 degrees F.
- C Maximum Compression: 1-3/4 inches.
- D Maximum Extension: 1/4 inch.
- E End Connections: Flanged.
- F Size: Use pipe sized units.
- G Application: Steel piping 2 inches and larger.

2.04 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE

- A Manufacturers:
 - 1. The Metraflex Company; _____: www.metralflex.com/#sle.
- B Pressure Rating: 125 psi and 400 degrees F.
- C Maximum Compression: 1-3/4 inches.
- D Maximum Extension: 1/4 inch.
- E End Connections: Externally pressurized with flanged ends.
- F Size: Use pipe sized units.
- G Application: Steel piping 3 inches and under.

2.05 EXPANSION JOINTS - SINGLE SPHERE, FLEXIBLE CONNECTOR

- A Manufacturers:
 - 1. The Metraflex Company; Cablesphere: www.metralflex.com/#sle.
- B Body Construction: Nylon-reinforced rubber tube.
- C Cover and Tube Elastomer: EPDM and EPDM.
- D End Connections: Carbon steel flanges.
- E Maximum Elongation: 3/8 inch.
- F Maximum Angular Movement: 15 degrees.

2.06 EXPANSION JOINTS - COMPENSATORS

- A Manufacturers:
- B Type: Two-ply 304 stainless steel bellows with carbon steel shroud.
- C Maximum Working Pressure: 200 psi.
- D Maximum Working Temperatures: 400 degrees F.
- E Maximum Compression: 1/2 inch.
- F End Connections: Female copper sweat.
- G Application: Copper piping up to 3 inches in size or steel piping up to 4 inches in size.

2.07 EXPANSION JOINTS - HOSE AND BRAID

- A Manufacturers:

1. The Metraflex Company; Metraloop: www.metralflex.com/#sle.
- B Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support brackets and plugged drain port for steam service.
- C Maximum Allowable Motion: 2 inch in the x, y, and z planes with no thrust loads to the building structure
- D Maximum Working Pressure: 150 psi at 800 degrees F.
- E Construction: Class 150, schedule 40, stainless steel hose and braid assembly with carbon steel fittings, including elbows and flanged end connections sized to match pipe segment
 1. Selected Product to Accommodate:
 - a. Compression and Expansion Axial Deflection: _____ inch.
 - b. Angular Rotation: 15 degrees.
 - c. Force developed by 1.5 times specified maximum allowable operating pressure.
 2. Provide necessary accessories including, but not limited to, swivel joints.

2.08 ACCESSORIES

- A Pipe Alignment Guides:
 1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
- B Engineered Riser Anchor Clamps:
 1. Applications:
 - a. Provide one clamp to serve as a riser clip.
 - 1) Verify the total load of filled pipe to be supported will be a safety factor of one less than the maximum loading of the clamp per the manufacturer's instructions.
 - b. Provide one clamp above and one clamp below the slab to anchor pipe.
 - 1) Coordinate with the structural engineer to determine the maximum thrust loading calculated for the slab or floor structure. Use the maximum thrust loading calculations to verify the clamps will be a safety factor of one less than the maximum loading of clamp per the manufacturer's instructions.
 2. Provide two piece, ductile iron in compliance with ASTM A536. Use with metal pipes with an outer diameter of 2.5 inches to 8 inches.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

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- E Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- F Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION 23 0516

SECTION 23 0517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A Section 07 8400 - Firestopping.

1.03 REFERENCE STANDARDS

- A ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.
- B ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2023a.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 WARRANTY

- A See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
- B Plastic or Sheet Metal: Pipe passing through interior walls, partitions, and floors, unless steel or brass sleeves are specified below.
- C Pipe Passing Through Below Grade Exterior Walls:
 - 1. Zinc coated or cast iron pipe.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- D Clearances:
 - 1. Provide allowance for insulated piping.

2. Wall, Floor, Partitions, and Beam Flanges: 1 inch greater than external pipe diameter including insulation.
3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 PIPE-SLEEVE SEALS

A Modular Mechanical Sleeve-Seal:

1. Elastomer-based interlocking links continuously fill annular space between pipe and wall-sleeve, wall or casing opening.
2. Watertight seal between pipe and wall-sleeve, wall or casing opening.
3. Size and select seal component materials in accordance with service requirements.
4. Glass-reinforced plastic pressure end plates.

B Pipe Sleeve Material:

1. Bearing Walls: Steel, cast iron, or terra-cotta pipe.
2. Masonry Structures: Sheet metal or fiber.

C Wall Sleeve: PVC material with waterstop collar, and nailer end-caps.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B Install piping to conserve building space, to not interfere with use of space and other work.
- C Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D Inserts:
 1. Provide inserts for placement in concrete formwork.
 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- E Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.

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2. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

F Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a water-tight seal.
6. Install in accordance with manufacturer's recommendations.

- G** When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

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

END OF SECTION 23 0517

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SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Pressure gauges and pressure gauge taps.
- B Thermometers and thermometer wells.

1.02 REFERENCE STANDARDS

- A ASME B40.100 - Pressure Gauges and Gauge Attachments; 2022.
- B ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014 (Reapproved 2025).
- C ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014 (Reapproved 2021).
- D UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

1.04 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Stainless Steel casing with brass or stainless burbon tube sensor.
 - 2. Size: 3-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.
 - 5. Liquid Filled: Glycerine

2.02 PRESSURE GAUGE TAPPINGS

- A Gauge Cock: Tee or lever handle, brass for maximum 150 psi.
- B 1/4" Copper tubing with isolation ball valves from suction and discharge of pumps.

2.03 STEM TYPE THERMOMETERS

- A Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.

2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.04 DIAL THERMOMETERS

- A Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 1. Size: 3 inch diameter dial.
 2. Lens: Clear glass.
 3. Accuracy: 1 percent.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Provide one pressure gauge per pump, installing taps on suction and discharge of pump. Pipe to gauge with valves.
- C Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D Install thermometers in air duct systems on flanges.
- E Provide instruments with scale ranges selected according to service with largest appropriate scale.
- F Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

SECTION 23 0529

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Support and attachment components.

1.02 RELATED REQUIREMENTS

- A Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.
- B Section 05 5000 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.03 REFERENCE STANDARDS

- A ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings; 1999, with Editorial Revision (2022).
- C ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- D ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General-Purpose Piping; 2023.
- F ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2018.
- G ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures; 1999 (Reapproved 2022).
- H ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- I ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- J ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- K ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- L ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- M FM (AG) - FM Approval Guide; Current Edition.
- N MFMA-4 - Metal Framing Standards Publication; 2004.
- O MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- P NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- Q UL (DIR) - Online Certifications Directory; Current Edition.

- R UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A Coordination:

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

B Sequencing:

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

1.05 SUBMITTALS

A See Section 01 3000 - Administrative Requirements for submittal procedures.

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

1. Fiberglass Channel (Strut) Framing Systems: Include requirements for strength derating according to ambient temperature.

C Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1. Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

D Installer's Qualifications: Include evidence of compliance with specified requirements.

E Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A Comply with applicable building code.

B Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

C Installer Qualifications for Field-Welding: As specified in Section 05 5000.

1.07 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS**2.01 SUPPORT AND ATTACHMENT COMPONENTS****A General Requirements:**

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

B Prefabricated Trapeze-Framed Metal Strut Systems:

1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
 - c. Gripple, Inc; Fast Track - Standard: www.gripple.com/#sle.
 - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
2. MFMA-4 compliant, pre-fabricated, MSS SP-58 type 59 continuous-slot metal strut channel with associated tracks, fittings, and related accessories.
3. Strut Channel or Bracket Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
4. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch.
5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
6. Accessories: Provide bracket covers, cable basket clips, cable tray clips, clamps, conduit clamps, fire-retarding brackets, j-hooks, protectors, and vibration dampeners.

C Prefabricated Trapeze-Framed Fiberglass Strut Systems:

1. MSS SP-58 type 59, prefabricated continuous-slot fiberglass strut channel, associated fittings, and related accessories.
2. Channel Material: Use polyester resin or vinyl ester resin.
3. Minimum Channel Dimensions: 1-5/8 inch width by 1 inch height.

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4. Flammability: Fire retardant with NFPA 101, Class A flame spread index (maximum of 25) when tested in accordance with ASTM E84; self-extinguishing in accordance with ASTM D635.

D Strut Channels:

1. Manufacturers:
 - a. B-Line, a brand of Eaton Corporation: www.eaton.com/#sle.
 - b. Gripple, Inc; Universal Bracket: www.gripple.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
2. ASTM A653/A653M galvanized steel bracket with clamps for surface mounting of piping or plumbing equipment support.
3. Channel or Bracket Kits: Include rods, brackets, end-fixed fittings, covers, clips, and other related hardware required to complete sectional trapeze section for piping or other support.

E Channel Nuts:

1. Provide carbon steel channel nut with epoxy copper or zinc finish and long, regular, or short spring.

F Hanger Rods:

1. Threaded zinc-plated steel unless otherwise indicated.
2. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch: 1/4 inch diameter.
 - c. Piping larger than 1 inch: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.

G Steel Cable:

1. Manufacturers:
 - a. Ductmate Industries, Inc, a DMI Company; Clutcher Cable Hanging System: www.ductmate.com/#sle.
 - b. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
 - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.

H Cable Hanging System Kits:

1. Manufacturers:
 - a. Ductmate Industries, Inc: ductmate.com/#sle.
 - b. Gripple, Inc: www.gripple.com/#sle.
 - c. Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
2. Provide cable-wire in bulk or precut lengths with respective cable hangers as required to hold minimum weight of 120 lb.
3. Accessories: Provide brackets, clip or c-clip hangers, covers, and y-hook hangers.

I Thermal Insulated Pipe Supports:

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1. General Requirements:
 - a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
2. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Minimum Service Temperature: Minus 40 degrees F.
 - c. Maximum Service Temperature: 180 degrees F.
 - d. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - e. Thickness: 60 mil.
 - f. Connections: Brush on welding adhesive.
3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.

J Beam Clamps:

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

K Riser Clamps:

1. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
2. MSS SP-58 type 1 or 8, carbon steel or steel with epoxy plated, plain, stainless steel, or zinc plated finish.

3. Medium Split Horizontal Pipe Clamp: MSS SP-58 type 4, carbon steel or stainless steel with epoxy plated, plain, stainless steel, or zinc plated finish.
 4. Copper Tube Pipe Clamp: MSS SP-58 type 8, epoxy plated copper.
 5. UL (DIR) listed: Pipe sizes 1/2 to 8 inch.
- L U-Bolts:
1. MSS SP-58 Type 24, carbon steel u-bolt for pipe support or anchoring.
- M Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- N Strut Clamps:
1. Pipe Clamp: Two-piece rigid, universal, or outer diameter type, carbon steel with epoxy copper or zinc finish.
- O Insulation Clamps:
1. Two bolt-type clamps designed for installation under insulation.
 2. Material: Carbon steel with epoxy copper or zinc finish.
- P Pipe Hangers:
1. Split Ring Hangers:
 - a. Provide hinged split ring and yoke roller hanger with epoxy copper or plain finish.
 - b. Material: ASTM A47/A47M malleable iron or ASTM A36/A36M carbon steel.
 - c. Provide hanger rod and nuts of the same type and material for a given pipe run.
 - d. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
 2. Swivel Ring Hangers, Adjustable:
 - a. MSS SP-58 Type 10, epoxy-painted, zinc-colored.
 - b. Material: ASTM A395/A395M ductile iron, ASTM A36/A36M carbon steel, ASTM A47/A47M malleable iron, ASTM A181/A181M forged steel, or ASTM A283/A283M steel.
 - c. FM (AG) and UL (DIR) listed for specific pipe size runs and loads.
 3. Clevis Hangers, Adjustable:
 - a. Copper Tube: MSS SP-58 Type 1, epoxy-plated copper.
 - b. Felt-Lined: MSS SP-58 Type 1, zinc-plated, silicone-free carbon steel.
 - c. Standard-Duty: MSS SP-58 Type 1, zinc-colored, epoxy plated.
 - d. UL (DIR) listed: Pipe sizes 2-1/2 to 8 inch.
 - e. FM (AG) listed: Pipe sizes 2-1/2 to 8 inch.
- Q Pipe Shields for Insulated Piping:
1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.

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- f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.

R Anchors and Fasteners:

1. Manufacturers - Mechanical Anchors:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Hilti, Inc: www.us.hilti.com/#sle.
 - b. Simpson Strong-Tie Company Inc: www.strongtie.com/#sle.
3. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
4. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Hollow Masonry: Use toggle bolts.
7. Hollow Stud Walls: Use toggle bolts.
8. Beam Ceiling Flanges: ASTM A47/A47M Grade 32510, malleable iron or stainless steel with copper, plain, stainless steel, or zinc finish.
9. Sheet Metal: Use sheet metal screws.
10. Wood: Use wood screws.
11. Plastic and lead anchors are not permitted.
12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

S Pipe Installation Accessories:

1. Thermal Insulated, Surface-Mounted Pipe Supports:
 - a. Manufacturers:
 - 1) Source Limitations: Furnish hardware, fittings, and accessories from single manufacturer.
 - b. Material: Carbon steel with epoxy copper or zinc finish.
 - c. Weather and UV light resistant foam, plastic, or rubber material with built-in strut.
Maximum Load: 50 lb for single pipe or multiple landed on top strut.
2. Seismic Bracing Hardware:
 - a. Cable Suspension Systems:
 - 1) Strut channel or bracket-fitted fitting with locking mechanism for pipe or equipment suspension using cable wires extended to surface-mounted end-fixing fittings.

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- 2) Provide cable wire and end-fixing as required to hold minimum weight of 120 lb.
- b. Cable Sway Bracing Systems:
 - 1) Cable wire hanger with fix and release spring mechanism enclosed using zinc housing with 302 stainless steel components for pipe or equipment suspension to surface-mounted end-fixing fittings.
 - 2) Provide cable wire and end-fixing as required to hold minimum weight of 25 lb.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that field measurements are as indicated.
- B Verify that mounting surfaces are ready to receive support and attachment components.
- C Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A Install products in accordance with manufacturer's instructions.
- B Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.
- D Unless specifically indicated or approved by Engineer, do not provide support from roof deck.
- E Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G Equipment Support and Attachment:
 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I Secure fasteners according to manufacturer's recommended torque settings.
- J Remove temporary supports.

3.03 FIELD QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.
- B Inspect support and attachment components for damage and defects.

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- C Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 23 0529

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SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Tags.
- B Adhesive-backed duct markers.
- C Stencils.
- D Pipe markers.
- E Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A Section 09 9123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- D Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A Air Terminal Units: Tags.
- B Dampers: Ceiling tacks, where located above lay-in ceiling.
- C Ductwork: Stencilled painting.
- D Piping: Pipe markers.
- E Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 TAGS

- A Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- B Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.03 ADHESIVE-BACKED DUCT MARKERS

- A Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B Style: Individual Label.
- C Color: Yellow/Black.

2.04 STENCILS

- A Stencils: With clean cut symbols and letters of following size:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
 6. Ductwork and Equipment: 2-1/2 inch high letters.
- B Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.

2.05 PIPE MARKERS

- A Color: Comply with ASME A13.1.
- B Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure-sensitive adhesive backing and printed markings.
- D Color code as follows:
1. Heating, Cooling, and Boiler Feedwater: Green with white letters.
 2. Compressed Air: Blue with white letters.

2.06 CEILING TACKS

- A Description: Steel with 3/4 inch diameter color coded head.
- B Color code as follows:
1. HVAC Equipment: Yellow.
 2. Fire Dampers and Smoke Dampers: Red.
 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B Apply stencil painting in accordance with Section 09 9123.
- C Install plastic pipe markers in accordance with manufacturer's instructions.
- D Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E Use tags on piping 3/4 inch diameter and smaller.

- F Install ductwork with stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

3.03 SCHEDULE

- A Provide labels in the following color codes for Laminated Plastic Duct Lables:
1. For air supply ducts: White letters on blue background.
 2. For air return ducts: White letters on blue background.
 3. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
- B Stenciled Duct-Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
1. For all air ducts: Black letters on white background.
- C Provide labels in the following color codes for Laminated Plastic Duct Lables:
1. For air supply ducts: White letters on blue background.
 2. For air return ducts: White letters on blue background.
 3. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
 4. Retain "Stenciled Duct-Label Option" Paragraph below only if stenciled labels are permitted.
 5. Stenciled Duct-Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
 6. For all air ducts: Black letters on white background.

END OF SECTION 23 0553

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SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Testing, adjustment, and balancing of air systems.
- B Testing, adjustment, and balancing of hydronic systems.

1.02 RELATED REQUIREMENTS

- A Section 01 2100 - Allowances: Inspection and testing allowances.

1.03 PRICE AND PAYMENT PROCEDURES

- A Cash Allowance: See Section 01 2100 for additional requirements.
- B Allowance includes testing, adjusting, and balancing of mechanical systems.

1.04 REFERENCE STANDARDS

- A ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- C Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Engineer and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A Perform total system balance in accordance with one of the following:
- B Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
- D TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- E Pre-Qualified TAB Agencies:
 - 1. Design Control.
 - 2. Balancing Professionals.
 - 3. MNDak Testing and Balancing

3.02 EXAMINATION

- A Verify that systems are complete and operable before commencing work. Installing Contractor shall ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Proper strainer baskets are clean and in place.
 - 15. Service and balance valves are open.
- B Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

3.03 PREPARATION

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

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

3.04 ADJUSTMENT TOLERANCES

- A Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A Field Logs: Maintain written logs including:
 - 1. Running log of events and issues.
 - 2. Discrepancies, deficient or uncompleted work by others.
 - 3. Contract interpretation requests.
 - 4. Lists of completed tests.
- B Ensure recorded data represents actual measured or observed conditions.
- C Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

- A Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C Measure air quantities at air inlets and outlets.
- D Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- F Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- G Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- H Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- I Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

- J Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- K For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.07 WATER SYSTEM PROCEDURE

- A Adjust water systems to provide required or design quantities.
- B Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D Effect system balance with automatic control valves fully open to heat transfer elements.
- E Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 SCOPE

- A Test, adjust, and balance the following:
 - 1. Boiler Feedwater Pumps.
 - 2. HVAC Pumps.
 - 3. Boilers
 - 4. Air Cooled Water Chillers.
 - 5. Packaged Roof Top Heating/Cooling Units.
 - 6. Gas Fired Dehumidifiers
 - 7. Computer Room Air Conditioning Units.
 - 8. Air Coils.
 - 9. Air Handling Units.
 - 10. Fans.
 - 11. Air Terminal Units.
 - 12. Air Inlets and Outlets.

END OF SECTION 23 0593

**SECTION 23 0713
DUCT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Duct insulation.
- B Duct liner.

1.02 REFERENCE STANDARDS

- A ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- B ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.
- C ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- D ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- E ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.
- F ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- G ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- H ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- I SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- J UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.04 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.
- C All insulation shall be replaced if subjected to water or moisture during installation. Contractor is not allowed to dry insulation in place.

1.06 FIELD CONDITIONS

- A Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

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

2.02 GLASS FIBER, FLEXIBLE

- A Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle. SoftR Ductwrap FRK
- B Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.25 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Density: 1.0 PCF
 - 5. Installed R Value: R-6 2" Thick
- C Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
 - 4. Provide 2" Staple Overlap
- D Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.
- E Tie Wire: Annealed steel, 16 gauge, 0.0508 inch diameter.

2.03 GLASS FIBER, RIGID

- A Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 - 4. Owens Corning Corporation; 700 Series FIBERGLAS Insulation: www.ocbuildingspec.com/#sle.
- B Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.

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FACILITY
BID PACKAGE #3

3. Maximum Water Vapor Absorption: 5.0 percent.
4. Maximum Density: 8.0 pcf.
- C Vapor Barrier Jacket:
 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 3. Secure with pressure-sensitive tape.
- D Vapor Barrier Tape:
 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.04 DUCT LINER

- A Manufacturers:
 1. Aeroflex USA, Inc; AEROFLEX Breathe-EZ: www.aeroflexusa.com/#sle.
 2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 3. CertainTeed Corporation: www.certainteed.com/#sle.
 4. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 5. Owens Corning Corporation; QuietR Rotary Duct Insulation: www.ocbuildingspec.com/#sle.
- B Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 180 degrees F.
 3. Fungal Resistance: No growth when tested according to ASTM G21.
 4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
 5. Minimum Noise Reduction Coefficients:
 - a. 1/2 inch Thickness: 0.30.
 - b. 1 inch Thickness: 0.40.
 6. Connection: Waterproof vapor barrier adhesive.
- C Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D Adhesive: Waterproof, fire-retardant type, ASTM C916.
- E Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install in accordance with NAIMA National Insulation Standards.
- C Insulated Ducts 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.
- D Insulated Ducts 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.
- E Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Install Rigid Fiber glass insulation. Finish with canvas jacket sized for finish painting.
- F External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 2. Secure insulation without vapor barrier with staples, tape, or wires.
 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 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.
- G Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES (ALL R VALUES ARE INSTALLED VALUES)

- A Insulation thickness of Ductwork shall be in accordance with table C403.12.3 of the IECC 2024 addition.
- B Exhaust Ducts Within 10 ft of Exterior Openings: R-6 Glass Fiber Flexible
- C Exhaust Ducts and Return Exposed to Outdoor Air: R-6 Glass Fiber Flexible for the first 10 feet.
- D Concealed Return and Exhaust Ducts in conditioned spaces: None
- E Outside Air Intake Ducts: R-12 combined.
1. Provide 2 layers of 2" glass fiber rigid insulation with offset seams.
- F Exposed and Concealed Supply Ducts prior to terminal box: R-6 Glass Fiber Flexible
- G Concealed Supply ducts After Terminal Boxes: R-6 Glass Fiber Flexible
- H Exposed Supply Ducts After Terminal Boxes: None

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- I All Ducts in Mechanical Rooms or in finished spaces: R-6 unless noted otherwise for increased R values
 - 1. Provide Rigid glass fiber with canvas jacket (10 feet above floor and below).
 - 2. Flexible glass fiber approved at all other locations.
- J Return air transfer above ceiling - 1/2" Duct Liner
- K Duct Liner - As noted on plans, 1/2" minimum thickness.
- L Exterior Ductwork: Double wall ductwork.

END OF SECTION 23 0713

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**SECTION 23 0716
HVAC EQUIPMENT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Equipment insulation.
- B Jacketing and accessories.

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 C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- D ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.
- E ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- F ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type); 2024.
- G ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- H ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- I ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- J UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.04 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with not less than three years of documented experience.
- B Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

- B Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.06 FIELD CONDITIONS

- A Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER, FLEXIBLE

- A Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B Insulation: ASTM C553; flexible, noncombustible.
 - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1,000 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with self-sealing longitudinal laps and butt strips.
 - 3. Secure with outward clinch expanding staples and vapor barrier mastic.
- D Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E Vapor Barrier Lap Adhesive: Compatible with insulation.
- F Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.03 GLASS FIBER, RIGID

- A Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Maximum Density: 8.0 pcf.

C Vapor Barrier Lap Adhesive: Compatible with insulation.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A Manufacturer:

1. Aeroflex USA, Inc; AEROFLEX EPDM Sheet/Roll: www.aeroflexusa.com/#sle.
2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
3. K-Flex USA LLC; Insul-Sheet: www.kflexusa.com/#sle.

B Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.

1. Minimum Service Temperature: Minus 40 degrees F.
2. Maximum Service Temperature: 220 degrees F.
3. Connection: Waterproof vapor barrier adhesive.

2.05 JACKETING AND ACCESSORIES

A PVC Plastic:

1. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Brush on welding adhesive.
2. Covering Adhesive Mastic: Compatible with insulation.

B Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that equipment has been tested before applying insulation materials.
- B Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Factory Insulated Equipment: Do not insulate.
- C Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten 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 equipment containing fluids below ambient temperature; insulate entire system.
- G Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.

- H For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- K Inserts and Shields:
 - 1. Application: Equipment 1-1/2 inches diameter or larger.
 - 2. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 3. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L Finish insulation at supports, protrusions, and interruptions.
- M Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.
- N Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.

3.03 SCHEDULE

- A Heating Systems: (Same Thickness as in HVAC Piping Insulation)
 - 1. Pump Bodies: 1" Elastomeric
 - 2. Heat Exchangers/Converters: 2" Fiberglass
 - 3. Air Separators: 2" Fiberglass
- B Cooling Systems: (Same thickness as noted in HVAC Piping Insulation)
 - 1. Pump Bodies: 1" Elastomeric
 - 2. Valve Bodies 1" Elastomeric
 - 3. Air Separators and Accessories: 1" Elastomeric
 - 4. Chiller Cold Surfaces (Not Factory Insulated): 1 1/2" fiberglass
 - 5. Cold Thermal Storage Tanks: 1 1/2" Fiberglass
 - 6. Equipment Exposed to Freezing with Heat Tracing: 1" Fiberglass

END OF SECTION 23 0716

**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Piping insulation.
- B Weather barrier coatings.
- C Jacketing and accessories.
- D Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 RELATED REQUIREMENTS

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.04 QUALITY ASSURANCE

- A Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 5 years of experience.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 FIELD CONDITIONS

- A Maintain ambient conditions required by manufacturers of each product.
- B Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

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

2.02 GLASS FIBER, RIGID

- A Manufacturers:
 1. CertainTeed Corporation: www.certainteed.com/#sle.
 2. Johns Manville Corporation: www.jm.com/#sle.
 3. Knauf Insulation: www.knaufinsulation.com/#sle.
 4. Owens Corning Corporation; Fiberglas Pipe Insulation ASJ: www.ocbuildingspec.com/#sle.
 5. Owens Corning Corporation; VaporWick Pipe Insulation: www.ocbuildingspec.com/#sle.
- B Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 2. Maximum Service Temperature: 850 degrees F.
 3. Maximum Moisture Absorption: 0.2 percent by volume.

- C Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
 - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- D Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- E Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- F Vapor Barrier Lap Adhesive: Compatible with insulation.
- G Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- H Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A Manufacturers:
 - 1. Aeroflex USA, Inc; AEROFLEX Self-Seal: www.aeroflexusa.com/#sle.
 - 2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 - 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
- B Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C Weather Barrier Coating: Air dried, contact adhesive, compatible with insulation and ASTM E84 compliant.

2.04 JACKETING AND ACCESSORIES

- A PVC Plastic.
 - 1. Manufacturers:
 - 2. Jacket: One or two piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil, 0.010 inch.
 - e. Connections: Brush on welding adhesive.
- B Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire-retardant lagging adhesive.
 - 1. Lagging Adhesive: Compatible with insulation.
- C Aluminum Jacket: For Exterior piping.

1. Comply with ASTM B209/B209M, Temper H14, minimum thickness of 0.016 inch with factory-applied polyethylene and kraft paper moisture barrier on the inside surface.
 2. Thickness: 0.016 inch sheet.
 3. Type: Factory-applied, self-adhesive jacketing.
 4. Finish: Embossed.
 5. Joining: Longitudinal slip joints and 2 inch laps.
 6. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 7. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
- D Reinforced Tape:
1. FSK tape suitable for sealing seams between insulation, insulated pipe bends, and fittings resulting in a tight, smooth surface without wrinkles.
 2. Comply with UL 723, ASTM E84.
 3. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.
- E Vapor Barrier Membranes: ASTM C1136, Type IX.
1. Multilayer Laminate Vapor Barrier:
 - a. Provide multilayer laminate with 1.0 mil, 0.001 inch foil, reversible.
 - b. Thickness: 2.4 mil, 0.002 inch.
 - c. Moisture Vapor Permeability: 0.00 perm inch, when tested in accordance with ASTM E96/E96M.

2.05 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

- A Manufacturers:
- B Basis of Design: Airex Manufacturing, Inc; www.airexmfg.com/#sle.
1. Refrigeration Pipe Insulation Protection System: Airex E-Flex Guard.
- C Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
 2. Outlet Cover Color: Gray.
- D Insulation Protection System: Refrigerant piping insulation PVC protective cover.
1. PVC Insulation Cover Color: Black with full-length velcro fastener.
 2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
 3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
 4. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

2.06 ACCESSORIES

- A General Requirements:
1. Furnish compatible materials which do not contribute to corrosion, soften, or otherwise attack surfaces to which applied, in either the wet or dry state.

- 2. Comply with ASTM C795 requirements for materials to be used on stainless steel surfaces.
- 3. Supply materials that are asbestos free.
- B Corrosion Inhibitors:
 - 1. Corrosion Control Gel:
 - a. Corrosion Protection: Comply with ASTM B117 and ASTM D610.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install in accordance with NAIMA National Insulation Standards.
- C Exposed Piping: Locate insulation and cover seams in least visible locations.
- D Insulated Pipes Conveying Fluids Below 50 degrees F and Ambient Temperature:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E Glass Fiber Insulated Pipes Conveying Fluids 50 degrees F and Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- F For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- G For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- H Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- I Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.

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- 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- J Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 8400.
- K Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

- A Heating Systems: Glass Fiber Rigid
 - 1. Heating Water Supply and Return (Hot water and Glycol Systems)
 - a. 140 Degrees F and below < 1.5" diameter shall be 1" Thick. 2" Diameter and greater shall be 1.5"
 - b. 141-200 degrees F < 1.5" diameter shall be 1" Thick. 2" Diameter and greater shall be 2"
 - c. Comply also with Table C403.12.3 of IECC 2021
- B Cooling Systems and Heat Pumps Systems - Glass Fiber Rigid unless specified otherwise.
 - 1. Chilled Water and Heat Pump Loops: < 1.5" diameter shall be 1/2" Thick. 2" Diameter and greater shall be 1"
 - 2. Refrigerant Suction: 1" Thick elastomeric with weather barrier or jacketed unless noted otherwise.
 - 3. Refrigerant Hot Gas: 1" Thick elastomeric with weather barrier or jacketed unless noted otherwise.
 - 4. Comply also with Table C403.12.3 of IECC 2021
- C Condensate Drain Piping: 1" Thick elastomeric with weather barrier or jacketed.
- D Other Systems:
 - 1. Piping Exposed to Freezing with Heat Tracing: 1 1/2" Thick
- E If there is a conflict between IECC 2021 Table C403.12.3 Minimum pipe insulation thickness and this specification. Use the thicker insulation value.

END OF SECTION 23 0719

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**SECTION 23 0800
COMMISSIONING OF HVAC**

PART 1 GENERAL

1.01 SUMMARY

- A See Section 01 9113 - General Commissioning Requirements for overall objectives; comply with the requirements of Section 01 9113.
- B This section covers the Contractor's responsibilities for commissioning; each subcontractor or installer responsible for the installation of a particular system or equipment item to be commissioned is responsible for the commissioning activities relating to that system or equipment item.
- C The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- D The entire HVAC system is to be commissioned, including commissioning activities for the following specific items:
 - 1. Control system.
 - 2. Major and minor equipment items.
 - 3. Piping systems and equipment.
 - 4. Terminal units.
 - 5. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- E The Prefunctional Checklist and Functional Test requirements specified in this section are in addition to, not a substitute for, inspection or testing specified in other sections.

1.02 REFERENCE STANDARDS

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

1.03 SUBMITTALS

- A Updated Submittals: Keep the Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B Draft Prefunctional Checklists and Functional Test Procedures for Control System: Detailed written plan indicating the procedures to be followed to test, checkout and adjust the control system prior to full system Functional Testing; include at least the following for each type of equipment controlled:
 - 1. System name.
 - 2. List of devices.
 - 3. Step-by-step procedures for testing each controller after installation, including:
 - a. Process of verifying proper hardware and wiring installation.
 - b. Process of downloading programs to local controllers and verifying that they are addressed correctly.
 - c. Process of performing operational checks of each controlled component.
 - d. Plan and process for calibrating valve and damper actuators and all sensors.

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- e. Description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
- 4. Copy of proposed log and field checkout sheets to be used to document the process; include space for initial and final read values during calibration of each point and space to specifically indicate when a sensor or controller has “passed” and is operating within the contract parameters.
- 5. Description of the instrumentation required for testing.
- 6. Indicate what tests on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the Commissioning Authority and TAB contractor for this determination.
- C Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of Commissioning Authority.
- D HVAC Control System O&M Manual Requirements. In addition to documentation specified elsewhere, compile and organize at minimum the following data on the control system:
 - 1. Specific step-by-step instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. Provide an index and clear table of contents. Include the detailed technical manual for programming and customizing control loops and algorithms.
 - 2. Full as-built set of control drawings.
 - 3. Full as-built sequence of operations for each piece of equipment.
 - 4. Full points list; in addition to the information on the original points list submittal, include a listing of all rooms with the following information for each room:
 - a. Floor.
 - b. Room number.
 - c. Room name.
 - d. Air handler unit ID.
 - e. Reference drawing number.
 - f. Air terminal unit tag ID.
 - g. Heating and/or cooling valve tag ID.
 - h. Minimum air flow rate.
 - i. Maximum air flow rate.
 - 5. Full print out of all schedules and set points after testing and acceptance of the system.
 - 6. Full as-built print out of software program.
 - 7. Electronic copy on disk of the entire program for this facility.
 - 8. Marking of all system sensors and thermostats on the as-built floor plan and HVAC drawings with their control system designations.
 - 9. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - 10. Control equipment component submittals, parts lists, etc.
 - 11. Warranty requirements.

12. Copies of all checkout tests and calibrations performed by the Contractor (not commissioning tests).
 13. Organize and subdivide the manual with permanently labeled tabs for each of the following data in the given order:
 - a. Sequences of operation.
 - b. Control drawings.
 - c. Points lists.
 - d. Controller and/or module data.
 - e. Thermostats and timers.
 - f. Sensors and DP switches.
 - g. Valves and valve actuators.
 - h. Dampers and damper actuators.
 - i. Program setups (software program printouts).
- E Project Record Documents: See Section 01 7800 for additional requirements.
1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.
- F Draft Training Plan: In addition to requirements specified in Section 01 7900, include:
1. Follow the recommendations of ASHRAE Guideline 1.1.
 2. Control system manufacturer's recommended training.
 3. Demonstration and instruction on function and overrides of any local packaged controls not controlled by the HVAC control system.
- G Training Manuals: See Section 01 7900 for additional requirements.
1. Provide three extra copies of the controls training manuals in a separate manual from the O&M manuals.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

- A Provide all standard testing equipment required to perform startup and initial checkout and required functional performance testing; unless otherwise noted such testing equipment will NOT become the property of Owner.
- B Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to Owner; such equipment, tools, and instruments are to become the property of Owner.

PART 3 EXECUTION

3.01 PREPARATION

- A Cooperate with the Commissioning Authority in development of the Prefunctional Checklists and Functional Test Procedures.

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

3.02 INSPECTING AND TESTING - GENERAL

- A Submit startup plans, startup reports, and Prefunctional Checklists for each item of equipment or other assembly to be commissioned.
- B Perform the Functional Tests directed by the Commissioning Authority for each item of equipment or other assembly to be commissioned.
- C Provide two-way radios for use during the testing.
- D Valve/Damper Stroke Setup and Check:
 - 1. For all valve/damper actuator positions checked, verify the actual position against the control system readout.
 - 2. Set pump/fan to normal operating mode.
 - 3. Command valve/damper closed; visually verify that valve/damper is closed and adjust output zero signal as required.
 - 4. Command valve/damper open; verify position is full open and adjust output signal as required.
 - 5. Command valve/damper to a few intermediate positions.
 - 6. If actual valve/damper position does not reasonably correspond, replace actuator or add pilot positioner (for pneumatics).
 - 7. Closure for Heating Coil Valves - Normally Open:
 - a. Set heating setpoint 20 degrees F above room temperature.
 - b. Observe valve open.
 - c. Remove control air or power from the valve and verify that the valve stem and actuator position do not change.
 - d. Restore to normal.
 - e. Set heating setpoint to 20 degrees F below room temperature.
 - f. Observe the valve close.
 - g. Restore to normal.
- E Isolation Valve or System Valve Leak Check: For valves not by coils.

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1. With full pressure in the system, command valve closed.
 2. Use an ultra-sonic flow meter to detect flow or leakage.
- F Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.03 TAB COORDINATION

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

3.04 CONTROL SYSTEM FUNCTIONAL TESTING

- A Prefunctional Checklists for control system components will require a signed and dated certification that all system programming is complete as required to accomplish the requirements of Contract Documents and the detailed Sequences of Operation documentation submittal.
- B Do not start Functional Testing until all controlled components have themselves been successfully Functionally Tested in accordance with Contract Documents.
- C Using a skilled technician who is familiar with this building, execute the Functional Testing of the control system as required by the Commissioning Authority.
- D Functional Testing of the control system constitutes demonstration and trend logging of control points monitored by the control system.
1. The scope of trend logging is partially specified; trend log up to 50 percent more points than specified at no extra cost to Owner.
 2. Perform all trend logging specified in Prefunctional Checklists and Functional Test procedures.
- E Functionally Test integral or stand-alone controls in conjunction with the Functional Tests of the equipment they are attached to, including any interlocks with other equipment or systems; further testing during control system Functional Test is not required unless specifically indicated below.
- F Demonstrate the following to the Commissioning Authority during testing of controlled equipment; coordinate with commissioning of equipment.
1. Setpoint changing features and functions.
 2. Sensor calibrations.
- G Demonstrate to the Commissioning Authority:

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1. That all specified functions and features are set up, debugged and fully operable.
 2. That scheduling features are fully functional and setup, including holidays.
 3. That all graphic screens and value readouts are completed.
 4. Correct date and time setting in central computer.
 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
 6. Functionality of field panels using local operator keypads and local ports (plug-ins) using portable computer/keypad; demonstrate 100 percent of panels and 10 percent of ports; if any ports fail, sample another 10 percent; if any of those fail, test all remaining units at no extra cost to Owner.
 7. Power failure and battery backup and power-up restart functions.
 8. Global commands features.
 9. Security and access codes.
 10. Occupant over-rides (manual, telephone, key, keypad, etc.).
 11. O&M schedules and alarms.
 12. Occupancy sensors and controls.
 13. All control strategies and sequences not tested during controlled equipment testing.
- H If the control system, integral control components, or related equipment do not respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice, under any of the conditions, sequences, or modes tested, correct all systems, equipment, components, and software required at no additional cost to Owner.

3.05 OPERATION AND MAINTENANCE MANUALS

- A See Section 01 7800 for additional requirements.
- B Add design intent documentation furnished by Engineer to manuals prior to submission to Owner.
- C Submit manuals related to items that were commissioned to Commissioning Authority for review; make changes recommended by Commissioning Authority.
- D Commissioning Authority will add commissioning records to manuals after submission to Owner.

3.06 DEMONSTRATION AND TRAINING

- A Demonstrate operation and maintenance of HVAC system to Owner' personnel; if during any demonstration, the system fails to perform in accordance with the information included in the O&M manual, stop demonstration, repair or adjust, and repeat demonstration. Demonstrations may be combined with training sessions if appropriate.
- B These demonstrations are in addition to, and not a substitute for, Prefunctional Checklists and demonstrations to the Commissioning Authority during Functional Testing.
- C TAB Review: Instruct Owner's personnel for minimum ____ hours, after completion of TAB, on the following:
 1. Review final TAB report, explaining the layout and meanings of each data type.

2. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 3. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 4. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 5. Other salient information that may be useful for facility operations, relative to TAB.
- D HVAC Control System Training: Perform training in at least three phases:
1. Phase 1 - Basic Control System: Provide minimum of 6 hours of actual training on the control system itself. Upon completion of training, each attendee, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of the system.
 - a. This training may be held on-site or at the manufacturer's facility.
 - b. If held off-site, the training may occur prior to final completion of the system installation.
 - c. For off-site training, Contractor shall pay expenses of up to two attendees.
 2. Phase 2 - Integrating with HVAC Systems: Provide minimum of 6 hours of on-site, hands-on training after completion of Functional Testing. Include instruction on:
 - a. The specific hardware configuration of installed systems in this facility and specific instruction for operating the installed system, including interfaces with other systems, if any.
 - b. Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - c. Trend logging and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends; provide practice in setting up trend logging and monitoring during training session.
 - d. Every display screen, allowing time for questions.
 - e. Point database entry and modifications.
 3. Phase 3 - Post-Occupancy: Six months after occupancy conduct minimum of 6 hours of training. Tailor training session to questions and topics solicited beforehand from Owner. Also be prepared to address topics brought up and answer questions concerning operation of the system.
- E Provide the services of manufacturer representatives to assist instructors where necessary.
- F Provide the services of the HVAC controls instructor at other training sessions, when requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.

END OF SECTION 23 0800

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SECTION 23 0913
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Control panels.
- B Control Valves:
 - 1. Ball valves with factory-mounted actuators.
 - 2. Electronic valve operators.
 - 3. Radiation valves.
- C Damper Operators:
 - 1. Electric operators.
- D Humidistats:
 - 1. Room humidistats.
 - 2. Limit duct humidistats.
- E Wall-, Surface-, and Duct-Mounted Sensors:
 - 1. Temperature sensors.
 - 2. Humidity sensors.
 - 3. IAQ (indoor air quality) sensors.
 - 4. Building static pressure transmitters.
 - 5. Static air pressure sensors.
 - 6. Air pressure transmitters.
 - 7. Airflow meters; thermal dispersion.
- F Thermostats:
 - 1. Freezestats.
 - 2. Line voltage thermostats.
 - 3. Room-mount thermostat accessories.
 - 4. Immersion thermostats.
 - 5. Airstream thermostats.
 - 6. Electric high/low limit duct thermostats.
- G Pipe-Mounted Sensors and Transmitters:
 - 1. Temperature sensors.
 - 2. Pressure transmitters.
 - 3. Flow switches.

1.02 RELATED REQUIREMENTS

- A Section 25 3513 - Integrated Automation Actuators and Operators.
- B Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.
- C Section 26 2726 - Wiring Devices: Elevation of exposed components.

1.03 REFERENCE STANDARDS

- A ANSI/FCI 70-2 - Control Valve Seat Leakage; 2021.

B ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata (2023).

C NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.

1.04 ADMINISTRATIVE REQUIREMENTS

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

B Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A See Section 01 3000 - Administrative Requirements for submittal procedures.

B Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

C Manufacturer's Instructions: Provide for all manufactured components.

D Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.06 QUALITY ASSURANCE

A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years experience approved by manufacturer.

1.07 WARRANTY

A See Section 01 7800 - Closeout Submittals for additional warranty requirements.

B Correct defective work within a 24 month period after Substantial Completion.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

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

2.02 CONTROL PANELS

A Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B NEMA EN 10250, general purpose utility enclosures with enameled finished face panel.

C Provide common keying for all panels.

D UL Listed

2.03 CONTROL DEVICE MANUFACTURER

A Manufacturers: Unless Noted Otherwise the following manufactures are approved equal for all aspects below. Additional manufacturers may be listed for specific items below.

1. Belimo Aircontrols (USA), Inc: www.belimo.com/#sle.

2. Johnson Controls International, PLC: www.johnsoncontrols.com/#sle.

3. Honeywell.

2.04 CONTROL VALVES

A Ball Valves with Factory-Mounted Actuators:

1. Manufacturers:
 - a. Belimo Aircontrols (USA), Inc: www.belimo.com/#sle.
 - b. Johnson Controls International, PLC: www.johnsoncontrols.com/#sle.
 - c. Honeywell.
2. Service: Use for brine (30 percent glycol), chilled water, hot water, or steam at 15 to 25 psig (104.4 to 172.4).
3. Flow Characteristic: Include 2-way, 3-way diverting, and 3-way mixing, and 6 way operation configured to fail as indicated on drawings. Shall also be equal percentage.
4. Replacements in Kind: Provide pressure-independent type.
5. Rangeability: 500 to 1.
6. ANSI Rating: Class 150.
7. Leakage: Class IV (0.1 percent of rated capacity) per ANSI/FCI 70-2.
8. Body Size:
 - a. Under 2-1/2 inches:
 - 1) Connection: NPT.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - b. 2-1/2 inches and Above:
 - 1) Connection Type: Flanged.
 - 2) Materials:
 - (a) Body: Brass.
 - (b) Flanges: Ductile iron.
 - (c) Ball: 300 series stainless steel.
 - (d) Stem: 300 series stainless steel.
 - (e) Seat: Graphite-reinforced PTFE with EPDM O-Ring backing.
 - (f) Stem Seal: EPDM O-Rings.
 - (g) Flow Control Disk: Thermoplastic synthetic-resin.
 - c. Service Temperature:
 - 1) Fluid Side: 0 to 284 degrees F liquid or 25 psig steam.
 - 2) Ambient Side: From minus 4 to 122 degrees F.

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9. Actuator Requirements:
 - a. Assembly: Factory-mounted.
 - b. Input: 0 to 10 VDC configured for proportional control.
 - c. Accessories: Provide with valve position indicator and manual override.
- B Electronic Valve Actuators:
 1. Manufacturers:
 - a. Honeywell International, Inc: buildingcontrols.honeywell.com/#sle.
 - b. Belimo.
 2. Valves shall spring return to normal position as indicated on freeze, fire, or temperature protection.
 3. Select operator for full shut-off at maximum pump differential pressure.
- C Radiation Valves:
 1. Bronze body, bronze trim, 2 or 3 port as indicated, replaceable plugs and seats, union and threaded ends.
 2. Rate for service pressure of 125 psig at 250 degrees F.
 3. Size for 3 psig maximum pressure drop at design flow rate.
 4. Provide two-way valves with equal percentage characteristics and three-way valves with linear characteristics. Size two-way valve operators to close valves against pump shut-off head.
 5. Modulating Operators: Self-contained, linear motorized actuator with approximately 3/4 inch stroke, 60 second full travel with transformer and SPDT contacts: 24 VDC, 6 W maximum input.

2.05 DAMPER OPERATORS

- A General:
 1. Provide actuators with torque capacity sized for minimum of 20 percent greater than maximum design stream velocity and hold tight seal against maximum system pressures.
 2. Provide spring return for two position control and for fail safe operation.
 3. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
 4. Provide one operator for maximum 36 sq ft damper section.
 5. See Section 25 3513 for field-mount damper actuators and operators.
- B Electric Operators:
 1. Manufacturers:
 - a. Belimo.
 2. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.06 HUMIDISTATS

- A Room Humidistats:
 1. Wall mounted, proportioning type.

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2. Throttling Range: Adjustable 2 percent relative humidity.
3. Operating Range: 30 to 80 percent.
4. Cover: Set point indication.

B Limit Duct Humidistats:

1. Insertion, two-position type.
2. Throttling Range: Adjustable 2 percent relative humidity.
3. Operating Range: 20 to 80 percent.
4. Maximum Temperature: 150 degrees F.

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

A Temperature Sensors:

1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy.
2. Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F.
3. 100 ohm platinum RTD is acceptable if used with project DDC controllers.
4. Temperature Sensing Device: Compatible with project DDC controllers.
5. Performance Characteristics:
 - a. RTD:
 - 1) Room Sensor Accuracy: Plus/minus 0.50 degrees F minimum.
 - 2) Duct Averaging Accuracy: Plus/minus 0.50 degrees F minimum.
 - 3) Chilled Water Accuracy: Plus/minus 0.50 degrees F minimum.
 - 4) All Other Accuracy: Plus/minus 0.75 degrees F minimum.
 - 5) Range: Minus 40 degrees F through 220 degrees F minimum.
 - b. Thermistor:
 - 1) Accuracy (All): Plus/minus 0.36 degrees F minimum.
 - 2) Range: Minus 25 degrees F through 122 degrees F minimum.
 - 3) Heat Dissipation Constant: 2.7 mW per degree C.
 - c. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.
 - d. Immersion Temperature Sensors: A sensor encased in a corrosion-resistant probe with an indoor junction box service entry body.
 - e. Room Temperature Sensors with Integral Digital Display:
 - 1) Provide a four button keypad with the following capabilities:
 - (a) Indication of space and outdoor temperatures.
 - (b) Setpoint adjustment to accommodate room setpoint, DDC Input/Output Points List, and Sequence of Operation.
 - (c) Display and control fan operation status.
 - (d) Manual occupancy override and indication of occupancy status.
 - (e) Controller mode status.
 - (f) Password enabled setpoint and override modes.

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- f. Temperature Averaging Elements:
 - 1) Use on duct sensors for ductwork 10 sq ft or larger.
 - 2) Use averaging elements where prone to stratification with sensor length 8 ft or 16 ft.
 - 3) Provide for all mixed air and heating coil discharge sensors regardless of duct size.
- g. Insertion Elements:
 - 1) Use in ducts not affected by temperature stratification or smaller than 11 sq inches.
 - 2) Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches.
- B Humidity Sensors, Outdoor-Mount:
 - 1. Digitally profiled thin-film capacitive sensor encased in a die-cast metal, weather-proof plastic or metal housing with solar shield.
 - 2. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
 - 3. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
 - 4. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.
 - 5. Temperature Sensor, Combined: Platinum RTD.
 - a. Transmitter: Fitted within device-interface enclosure, calibrated.
 - b. Monitoring Range: 32 to 122 degrees F, adjustable.
 - c. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
 - d. Accuracy: Plus/minus three percent. Adjustable on the transmitter end.
 - 6. Service Temperature: Minus 40 to 122 degrees F.
 - 7. Service Humidity: 0 to 100 percent RH, noncondensing.
- C Humidity Sensors, Duct-Mounted:
 - 1. Digitally profiled thin-film capacitive sensor probe extended from die-cast metal, weather-proof plastic or metal housing designed for duct mounting.
 - 2. Measuring Scale: 0 to 100 percent RH, noncondensing, temperature compensated.
 - 3. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
 - 4. Accuracy: Plus/minus 1 percent between 20 to 40 percent RH linear range, NIST traceable with multi-point calibration.
 - 5. Temperature Sensor, Combined: Platinum RTD.
 - a. Transmitter: Fitted within device-interface enclosure, calibrated.
 - b. Monitoring Range: 32 to 122 degrees F, adjustable.
 - c. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
 - d. Accuracy: Plus/minus three percent. adjustable on the transmitter end.
 - 6. Service Temperature: Minus 40 to 122 degrees F
 - 7. Service Humidity: 0 to 100 percent RH, noncondensing.

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D Humidity Transmitters, Surface-Mounted:

1. Plastic housing encased, wall-mounted, humidity and temperature indicating sensor.
2. Humidity Sensor Type: Thin-film capacitive.
3. Accuracy: 1 percent at rated measuring scale and capable of withstanding 95 percent relative humidity without loss of calibration.
4. Output: Two-wire, 4 to 20 mA, 0 to 5 VDC or 0 to 10 VDC, non-loop powered, selectable.
5. User Control Interface: Include button for setpoint and override control.
6. Temperature Sensor, Combined: Platinum RTD.

E IAQ (Indoor Air Quality) Sensors:

1. Form Factor: Surface mounted, desk mounted, or single-gang electrical-box-mounted module made of high-impact plastic or other resilient material.
2. Temperature Sensor:
 - a. Solid-state, integrated circuit type, 32 to 122 deg F range.
 - b. Accuracy: Plus/minus two percent within 0.1 deg resolution.
3. CO2 (Carbon Dioxide) Monitoring Sensor:
 - a. Non-dispersive infrared (NDIR) type, 0 to 100 %RH range.
 - b. Accuracy: Plus/minus 30 ppm within three percent of measured value.
4. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.

F Building Static Pressure Transmitters:

1. Single port for direct or tubing connection into wall or ceiling static pressure tap, direct acting, double bell, scale range 0.01 to 6.0 in-wc positive or negative, and sensitivity of 0.0005 in-wc. Transmit electronic signal to receiver with matching scale range.

G Static-Air Pressure Sensors:

1. Unidirectional with ranges not exceeding 150 percent of maximum expected input.
2. Temperature compensate with typical thermal error or 0.06 percent of full scale in temperature range of 40 to 100 degrees F.
3. Accuracy: One percent of full scale with repeatability 0.3 percent.
4. Output: 0 to 5 vdc with power at 12 to 28 vdc.

H Air Pressure Transmitters:

1. General: Provide dry air media, differential pressure transducers to monitor duct pressure.
2. Display: Signed 3-1/2 digit LCD, indicates pressure with over-range indicator.
3. Accuracy: Plus/minus 2 percent full scale of range with combined linearity and hysteresis.
4. Zero Adjust: Pushbutton auto-zero and digital input using 2-position terminal block.
5. Measuring Range: 1 to 10 in-wc, unidirectional or bidirectional.
6. Response Time: 2 seconds, adjustable.
7. Hardwired Output: 2-wire, loop-powered 4 to 20 mA, field selectable.
8. Service Temperature: 32 to 122 degrees F.

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9. Manual Reset
- I Airflow Meters; Thermal Dispersion:
 1. Manufacturers:
 - a. Ebtron, Inc: www.ebtron.com/#sle.
 - b. Ruskin Company: www.ruskin.com/#sle.
 2. Configuration: Duct or plenum inserted assembly using up to eight water-resistant thermal dispersion sensors per metal probe wired into external access box holding self-diagnosing sensor interface electronics with respective field wire and cable landing terminals.
 3. Provide thermal dispersion flow meters complete with matched transducers, self aligning installation hardware, and transducer cables.
 4. Optimize thermal dispersion transducer for the specific duct or pipe and process conditions for the application.
 5. Signal Monitoring Range:
 - a. Air Velocity: 0 to 2000 fpm, bidirectional converted to airflow using section area and air velocity from listed range.
 - b. Temperature: 32 to 104 degrees F.
 - c. Humidity: 5 to 95 percent RH, noncondensing.
 - d. Enthalpy: Calculate using temperature and humidity signal.
 6. Accuracy: Plus or minus 1 percent, NIST with a plus or minus 0.25 percent repeatability over listed range. Include means to zero, adjust, and calibrate outputs.
 7. Access Box: NEMA EN 10250, Type 1 with hinged cover housing and cable access ports.
 8. Interface: Fitted with 16-character, 2-line, backlit, alphanumeric display and labeled pad-type surface membrane buttons.
 9. Outputs: Two-wire, 4 to 20 mA, for each measured signal, configurable.

2.08 THERMOSTATS

- A Freezestats:
 1. Configuration: Vapor-filled capillary.
 2. Probe Sensing Length: 20 feet.
 3. Setpoint Adjust Control: Screw with manual reset switch.
 4. Switch Type: SPDT, snap-action, form C in dust-protected enclosure.
 5. Mounting: Locate on cooling coil intake side.
 6. Field Interface: Connect load line-voltage to starter.
 7. Electrical Rating: As indicated on drawings.
- B Line Voltage Thermostats:
 1. Dead Band: Maximum 2 degrees F.
 2. Cover: Locking with set point adjustment, with thermometer.
 3. Rating: Motor load.

- C Room-Mounted Thermostat Accessories:
 - 1. Insulating Bases: For thermostats located on exterior walls.
 - 2. Thermostat Guards: Locking transparent plastic mounted on separate base.
 - 3. Adjusting Key: As required for device.
- D Immersion Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.
- E Airstream Thermostats:
 - 1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
 - 2. Averaging service remote bulb element: 7.5 feet.
- F Electric High/Low Limit Duct Thermostats:
 - 1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is above, equal to, or below setpoint,
 - 2. Bulb length: Minimum 20 feet.
 - 3. Provide one thermostat for every 20 sq ft of coil surface.

2.09 PIPE-MOUNTED SENSORS AND TRANSMITTERS

- A Temperature Sensors:
 - 1. Pipe-mounted temperature probe tied to weather-resistant enclosure for direct insertion into compatible liquids or gases or inserted into intermediary thermal grease-filled pipe-well compatible with interfaced fluid.
 - 2. Sensor Type: 1,000 ohm Platinum RTD.
 - 3. Transmitter: Fitted within probe-interface enclosure, calibrated.
 - a. Monitoring Range: 32 to 122 degrees F, adjustable.
 - b. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
 - c. Accuracy: Plus/minus three percent. adjustable on the transmitter end.
- B Pressure Transmitters:
 - 1. Self-contained transducer for monitoring of pneumatic, gas, liquid, or steam service with proportional range scaled over selected electronic output.
 - 2. Service Monitoring Range: 0 to 100 psig.
 - 3. Wetted Material: Brass for general service or stainless steel for steam and corrosive.
 - 4. Hardwired Output: Two-wire, 4 to 20 mA, loop powered.
- C Thermal Dispersion Flow Switch
 - 1. Applications:
 - a. Blower Flow
 - b. Hot Water Heaters
 - c. Chillers
 - 2. Service: Compatible water-based fluids.
 - 3. Wetted Materials: 316 SS.

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4. Setpoint Range: 0.5 to 10 ft/s (0.15 to 3.0 m/s).
5. Repeatability: 0.07 ft/s +3% of setpoint.
6. Typical Deadband: 0.1 ft/s +15% of setpoint.
7. Temperature Limits: Ambient: 5 to 140°F (-15 to 60°C), Process: 5 to 140°F (-15 to 60°C), Storage: -40 to 185°F (-40 to 85°C).
9. Pressure Limits: 300 psig (20.67 bar).
10. Response Time: Approximately 8 s.
11. Power Requirement: 9-24 VDC.
12. Switching Current: 400 mA, derate 5 mA/°C above 23°C.
13. Current Consumption: Average: 93 mA, Peak: 300 mA.
14. Electrical Connection: 1/2" NPT cable gland with 4 conductor 22 AWG, 6' (1.83 m) cable.
16. Process Connection: 1/2" NPT male.
17. Enclosure Rating: NEMA 4X (IP65).
18. Housing Materials: 316 SS, 416 SS, polycarbonate, neoprene, and acrylated urethane.
20. Switch Type: 1 NO NPN, 1 NC NPN.
21. Input Power and Protection: 0.5A fuse (resettable) reverse polarity protected.
22. Switched Output Protection: 0.5A fuse (resettable) reverse polarity protected.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify existing conditions before starting work.
- B Verify that systems are ready to receive work.
- C Beginning of installation means installer accepts existing conditions.
- D Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- E Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
- F Ensure installation of components is complementary to installation of similar components.
- G Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION

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

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3.03 MAINTENANCE

- A Provide service and maintenance of control system for 24 Months from Date of Substantial Completion.
- B Provide complete service of controls systems, including call backs, and submit written report of each service call.
- C In addition to normal service calls, make minimum of 2 per year complete normal inspections of approximately 6 hours duration to inspect, calibrate, and adjust controls.

3.04 SCHEDULES PROVIDED BY CONTROL CONTRACTOR

- A Control Damper Schedule

END OF SECTION 23 0913

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SECTION 23 0923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A Section 23 0913 - Instrumentation and Control Devices for HVAC.
- B Section 23 0993 - Sequence of Operations for HVAC Controls.
- C Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata (2023).
- B MIL-STD-810 - Environmental Engineering Considerations and Laboratory Tests; 2019h, with Editorial Revision (2022).

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data for each system component and software module.
- C Shop Drawings:
 - 1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
 - 2. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration digital media containing graphics.
 - 3. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
 - 4. Indicate description and sequence of operation of operating, user, and application software.
- D Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.
- E Manufacturer's Qualification Statement.

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- F Installer's Qualification Statement.
- G Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 - 1. Revise shop drawings to reflect actual installation and operating sequences.
 - 2. Include submittals data in final "Record Documents" form.
- H Operation and Maintenance Data:
 - 1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
 - 2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
 - 3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- I Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A Designer Qualifications: Perform design of system using manufacturer's software under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.
- B Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 5 years of documented experience.
- C Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.

1.07 WARRANTY

- A Correct defective Work within a five year period after Substantial Completion.
- B Provide 3 year manufacturer's warranty for field programmable micro-processor based units including all software upgrades.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Johnson Controls, Inc: www.johnsoncontrols.com/#sle. Metasys Based
- B Schneider Electric: www.schneider-electric.us/#sle. Niagara Based
- C Distech Controls Niagara Based
- D JCI Facility Explorers. Niagara Based
- E Honeywell Webs N4

2.02 SYSTEM DESCRIPTION

- A This will be an extension of the Niagara based system being installed. The final system for the complete building will be controlled by a single log in and the dynamic graphics shall match phase I graphics as approved by engineer.
- B Automatic temperature control field monitoring and control system using field programmable micro-processor based units.

- C Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network and/or IP networks, with central and remote hardware, software, and interconnecting wire and conduit.
- D Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- E Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 0913.
- F Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
- G Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
- H The software framework shall be Niagara based which can be integrated into a web browsers. JCI Metasys shall be integrated to web browsers
- I All graphics shall be mobile device friendly.

2.03 OPERATOR INTERFACE

- A BACnet protocol to comply with ASHRAE Std 135.
- B Hardware:
 - 1. Cabinet or Wall Mounted Device:
 - a. Provide remote system access via Touch Screen with browser agnostic connectivity, including controller point monitor and control access to all data connected to the JACE controller which is powered by Niagara 4 or later. (JCI Metasys is approved equal).

2.04 CONTROLLERS

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

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- i. Web Enabled
 - j. Niagra 4 Framework or approved equal JCI Metasys
- 2. Communication:
 - a. Controller to reside on a BACnet network using ISO 8802-3 (ETHERNET) Data Link/Physical layer protocol.
 - b. Perform routing when connected to a network of custom application and application specific controllers.
 - c. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
- 3. External Input-Output (I-O) Data Bus:
 - a. Input only modules.
 - b. Output only modules.
 - c. Variable frequency drives (VFD's).
 - d. Universal I-O module (configurable).
- 4. Anticipated Environmental Ambient Conditions:
 - a. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
- 5. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
- 6. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
- 7. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
- B Custom Application Controller:
 - 1. General:
 - a. Provide sufficient memory to support controller's operating system, database, and programming requirements.
 - b. Share data between networked, microprocessor based controllers.
 - c. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.
 - d. Utilize real-time clock for scheduling.
 - e. Continuously check processor status and memory circuits for abnormal operation.

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- f. Controller to assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.
 - g. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.
 - 3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 - 4. Provisions for Serviceability:
 - a. Diagnostic LED's for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 - 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 - 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.
 - 7. Provide Color display and menu buttons for control.
 - 8. Capable of adding I/O Expansion Modules
- C Application Specific Controllers:
 - 1. General:
 - a. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.
 - b. Customized for operation within the confines of equipment served.
 - c. Communication with other network devices to be based on assigned protocol.
 - 2. Communication:
 - a. Controller to reside on a BACnet network using MS/TP Data Link/Physical layer protocol.
 - b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

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3. Anticipated Environmental Ambient Conditions:
 - a. Outdoors and/or in Wet Ambient Conditions:
 - 1) Mount within waterproof enclosures.
 - 2) Rated for operation at 40 to 150 degrees F.
 - b. Conditioned Space:
 - 1) Mount within dustproof enclosures.
 - 2) Rated for operation at 32 to 120 degrees F.
 4. Provisions for Serviceability:
 - a. Diagnostic LEDs for power, communication, and processor.
 - b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.
 5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.
 6. Power and Noise Immunity:
 - a. Maintain operation at 90 to 110 percent of nominal voltage rating.
 - b. Perform orderly shutdown below 80 percent of nominal voltage.
 - c. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 feet.
 7. Smart Thermostat:
 - a. Alphanumeric color display with button interface, white faceplate or fascia, multi-language support, surface or wall-mount over single gang box.
 - b. Built-in Inputs: 3-universal, configurable.
 - c. Built-in Outputs: 4-universal, configurable.
 - d. Sensor: 1,000 ohm Platinum RTD within insulated thermoplastic enclosure.
 - e. Adjustments: Setpoint, schedules, and point alarm criteria.
 - f. Temperature Control: Heating or cooling, On/Off control.
 - g. Primary Interface: ASHRAE Std 135 BACnet MS/TP communications.
 - h. Certification: BACnet Testing Laboratory (BTL) certified device listed under the BACnet Smart Sensor (B-SS) device profile in compliance with ASHRAE Std 135.
- D Input/Output Interface:
1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
 2. All Input/Output Points:
 - a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
 - b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.
 3. Binary Inputs:

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

2.05 POWER SUPPLIES AND LINE FILTERING

A Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
 2. Limit connected loads to 80 percent of rated capacity.
 3. Match DC power supply to current output and voltage requirements.
 4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
 5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
 6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
 7. Operational Ambient Conditions: 32 to 120 degrees F.
 8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD-810 for shock and vibration.
 9. Line voltage units UL recognized and CSA approved.
- B Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
 2. Minimum surge protection attributes:
 - a. Dielectric strength of 1000 volts minimum.
 - b. Response time of 10 nanoseconds or less.
 - c. Transverse mode noise attenuation of 65 dB or greater.
 - d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.
 3. Provide Battery Backup for all Panel Power supplies for 8 hours.

2.06 LOCAL AREA NETWORK (LAN)

- A Provide communication between control units over local area network (LAN).
- B LAN Capacity: Not less than 60 stations or nodes.
- C Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D LAN Data Speed: Minimum 19.2 Kb.
- E Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
- F Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
- G Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.07 SYSTEM SOFTWARE

- A Operating System:
1. Concurrent, multi-tasking capability.

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- a. Common Software Applications Supported: Microsoft Excel and Microsoft Office Platforms.
- 2. System Graphics:
 - a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
 - b. Animation displayed by shifting image files based on object status.
 - c. Provide method for operator with password to perform the following:
 - 1) Move between, change size, and change location of graphic displays.
 - 2) Modify on-line.
 - 3) Add, delete, or change dynamic objects consisting of:
 - (a) Analog and binary values.
 - (b) Dynamic text.
 - (c) Static text.
 - (d) Animation files.
- 3. Custom Dynamic Graphics Generation Package:
 - a. Create, modify, and save graphic files and visio format graphics in PCX formats.
 - b. HTML graphics to support web browser compatible formats.
 - c. Capture or convert graphics from AutoCAD.
- 4. Standard Dynamic HVAC Graphics Library:
 - a. HVAC Equipment:
 - 1) Boilers.
 - 2) Air Handlers.
 - 3) Terminal HVAC Units.
 - 4) Fan Coil Units.
 - b. Ancillary Equipment:
 - 1) Fans.
 - 2) Pumps.
 - 3) Coils.
 - 4) Valves.
 - 5) Piping.
 - 6) Dampers.
 - 7) Humidifier.
- B System Applications:
 - 1. Automatic System Database Save and Restore Functions:
 - a. Current database copy of each Building Controller is automatically stored on hard disk.
 - b. Automatic update occurs upon change in any system panel.
 - c. In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
 - a. Save database from any system panel.
 - b. Clear a panel database.
 - c. Initiate a download of a specified database to any system panel.
3. Software provided allows system configuration and future changes or additions by operators under proper password protection.
4. On-line Help:
 - a. Context-sensitive system assists operator in operation and editing.
 - b. Available for all applications.
 - c. Relevant screen data provided for particular screen display.
 - d. Additional help available via hypertext.
5. Security:
 - a. Operator log-on requires user name and password to view, edit, add, or delete data.
 - b. System security selectable for each operator.
 - c. System supervisor sets passwords and security levels for all other operators.
 - d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
 - e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
 - f. All system security data stored in encrypted format.
6. System Diagnostics:
 - a. Operations Automatically Monitored:
 - 1) Workstations.
 - 2) Printers.
 - 3) Modems.
 - 4) Network connections.
 - 5) Building management panels.
 - 6) Controllers.
 - b. Device failure is annunciated to the operator.
7. Alarm Processing:
 - a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
 - b. Configurable Objects:
 - 1) Alarm limits.
 - 2) Alarm limit differentials.
 - 3) States.
 - 4) Reactions for each object.
8. Alarm Messages:
 - a. Descriptor: English language.

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- b. Recognizable Features:
 - 1) Source.
 - 2) Location.
 - 3) Nature.
- 9. Configurable Alarm Reactions by Application and Time of Day:
 - a. Logging.
 - b. Starting programs.
 - c. Displaying messages.
 - d. Dialing out to remote locations.
 - e. Texting and Email
 - f. Providing audible annunciation.
 - g. Displaying specific system graphics.
- 10. Custom Trend Logs:
 - a. Definable for any data object in the system including interval, start time, and stop time.
 - b. Trend Data:
 - 1) Sampled and stored on the building controller panel.
 - 2) Archivable on hard disk.
 - 3) Retrievable for use in reports, spreadsheets and standard database programs.
 - 4) Archival on LAN accessible storage media including hard disk, tape, Raid array drive, and virtual cloud environment.
 - 5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.
- 11. Alarm and Event Log:
 - a. View all system alarms and change of states from any system location.
 - b. Events listed chronologically.
 - c. Operator with proper security acknowledges and clears alarms.
 - d. Alarms not cleared by operator are archived to the workstation hard disk.
- 12. Object, Property Status and Control:
 - a. Provide a method to view, edit if applicable, the status of any object and property in the system.
 - b. Status Available by the Following Methods:
 - 1) Menu.
 - 2) Graphics.
 - 3) Custom Programs.
- 13. Reports and Logs:
 - a. Reporting Package:
 - 1) Allows operator to select, modify, or create reports.
 - 2) Definable as to data content, format, interval, and date.

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- 3) Archivable to hard disk.
- b. Real-time logs available by type or status such as alarm, lockout, normal, etc.
- c. Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
- d. Set to be printed on operator command or specific time(s).
- 14. Reports:
 - a. Standard:
 - 1) Objects with current values.
 - 2) Current alarms not locked out.
 - 3) Disabled and overridden objects, points and SNVTs.
 - 4) Objects in manual or automatic alarm lockout.
 - 5) Objects in alarm lockout currently in alarm.
 - 6) Logs:
 - (a) Alarm History.
 - (b) System messages.
 - (c) System events.
 - (d) Trends.
 - b. Custom:
 - 1) Daily.
 - 2) Weekly.
 - 3) Monthly.
 - 4) Annual.
 - 5) Time and date stamped.
 - 6) Title.
 - 7) Facility name.
 - c. Tenant Override:
 - 1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
 - 2) Annual report showing override usage on a monthly basis.
 - d. Electrical, Fuel, and Weather:
 - 1) Electrical Meter(s):
 - (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
 - (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
 - 2) Fuel Meter(s):
 - (a) Monthly showing daily natural gas consumption for each meter.
 - (b) Annual summary showing monthly consumption for each meter.
 - 3) Weather:

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- (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

C Workstation Applications Editors:

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

- 9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.08 CONTROLLER SOFTWARE

- A All applications reside and operate in the system controllers and editing of all applications occurs at the system interface level via web application.
- B System Security:
 1. User access secured via user passwords and user names.
 2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
 3. User Log On/Log Off attempts are recorded.
 4. Automatic Log Off occurs following the last keystroke after a user defined delay time.
- C Object or Object Group Scheduling:
 1. Weekly Schedules Based on Separate, Daily Schedules:
 - a. Include start, stop, optimal stop, and night economizer.
 - b. 10 events maximum per schedule.
 - c. Start/stop times adjustable for each group object.
 2. Exception Schedules:
 - a. Based on any day of the year.
 - b. Defined up to one year in advance.
 - c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.
 3. Holiday or Special Schedules:
 - a. Capability to define up to 99 schedules.
 - b. Repeated annually.
 - c. Length of each period is operator defined.
- D Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.
- E Alarms:
 1. Binary object is set to alarm based on the operator specified state.
 2. Analog object to have high/low alarm limits.
 3. All alarming is capable of being automatically and manually disabled.
 4. Alarm Reporting:
 - a. Operator determines action to be taken for alarm event.
 - b. Alarms to be routed to appropriate workstation.
 - c. Reporting Options:
 - 1) Graphical displays.
 - 2) Email and Phone Texting
- F Demand Limiting:

1. Building power consumption monitored from signals generated by a pulse generator, mounted at the building power meter.
 2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner.
 3. Demand Reduction Methods:
 - a. Supply air temperature reset.
 - b. Equipment off/on prioritization.
 4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.
 5. Operator On-Line Changes Allowed:
 6. Information and Reports available Hourly, Daily, and Monthly:
- G Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.
- H PID Control Characteristics:
1. Direct or reverse action.
 2. Anti-windup.
 3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.
 4. User selectable controlled variable, set-point, and PED gains.
- I Staggered Start Application:
1. Prevents all controlled equipment from simultaneously restarting after power outage.
 2. Order of equipment startup is user selectable.
- J Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
 2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
 3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.
- K Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
 2. Allows minimum on-time and off-time to be selected.
- L On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
 2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.
- M Run-Time Totalization:
1. Totalize run-times for all binary input objects.
 2. Provides operator with capability to assign high run-time alarm.

2.09 HVAC CONTROL PROGRAMS

A General:

1. Support Inch-pounds and SI (metric) units of measurement.
 2. Identify each HVAC Control system.
 3. See Mechanical sheets for control sequences
- B Optimal Run Time:
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 4. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run time system normal start times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
 5. HVAC point summary:
 - a. Control system identifier and status.
- C Supply Air Reset:
1. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
- D Enthalpy Switchover:
1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.

2.10 GAS FIRED DEHUMIDIFICATION PROGRAMS

- A Gas fired dehumidification program sequences shall be provided by unit manufacturer.
- B Monitoring and control of unit shall be by BAS.

2.11 CHILLER CONTROL PROGRAMS

- A Chilled Water Reset: Automatically reset controlled chilled water temperature satisfying cooling coil requiring greatest cooling.
- B Chiller Sequencing: Determine which combination of chillers will most efficiently satisfy chilled water load, by cycling chillers, based on comparing load to switchover limits defined for each chiller.
- C See Mechanical sheets for control sequences

PART 3 EXECUTION**3.01 INSTALLERS**

- A Installer List: (Minimum of 5 years experience for contractor and primary installing personnel.
 - 1. Honeywell and Authorized Honeywell Installers.
 - a. Honeywell Corporate - Comfort Point
 - b. Wired 3d - Webs N4
 - 2. Johnson Controls and Authorized JCI Installation Contractors.
 - 3. Johnson Controls Facility Explorer by Authorized Contractors
 - 4. Schnieder Electric and Distech Controls and Authorized Disctech Installation Contractors
 - a. Climate Control
 - b. Energy Tech Systems
 - 5. Prior Approved Installation Contractors within 100 miles of the project site for service.

3.02 EXAMINATION

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

3.03 INSTALLATION

- A Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 0993.
- C Provide with 120v AC, 15 amp dedicated power circuit to each programmable control unit.
- D Provide conduit and electrical wiring in accordance with Section 26 0583. Electrical material and installation shall be in accordance with appropriate requirements of Division 26.
- E Provide conduit and electrical wiring as per current NEC requirements.
- F Provide conduit for all control and power wiring when installed in the following areas.
 - 1. Above ceilings in plenum areas without raceways and within 5 feet of terminal boxes.
 - 2. Exposed unfinished areas.
 - 3. Exposed in finished areas where conduit to be surface mounted to be painted to match walls.
 - 4. Down walls to thermostats
 - 5. Color of conduit shall be a coordinated with construction team.

3.04 MANUFACTURER'S FIELD SERVICES

- A Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.
- B Provide basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 40 hours dedicated instructor time and record training or provide training specific vidoes.

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3.05 DEMONSTRATION AND INSTRUCTIONS

- A Demonstrate complete and operating system to Owner.

3.06 MAINTENANCE

- A Provide service and maintenance of energy management and control systems for 3 years from Date of Substantial Completion.
- B Provide 6 complete inspections, one in each season, to inspect, calibrate, and adjust controls as required, and submit written reports throughout the contract.
- C Clear all alarms and provide description and correction

END OF SECTION 23 0923

SECTION 23 0934

VARIABLE-FREQUENCY MOTOR CONTROLLERS FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Variable-frequency motor controllers for low-voltage (600 V and less) AC motor applications.
- B Overcurrent protective devices for motor controllers, including overload relays.

1.02 RELATED REQUIREMENTS

- A Section 23 0529 - Hangers and Supports for HVAC Piping and Equipment.
- B Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.03 REFERENCE STANDARDS

- A IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code); 1989 (Corrigendum 2019).
- B NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C NEMA IA 10030 - Industrial Control and Systems: Enclosures; 2024.
- D NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts; 2008 (Reaffirmed 2020).
- E NEMA ICS 61800-2 - Adjustable Speed Electrical Power Drive Systems, Part 2: General Requirements-Rating Specifications for Low Voltage Adjustable Frequency AC Power Drive Systems; 2005.
- F NEMA IS 10033 - Industrial Control and Systems: Adjustable-Speed Drives; 2026.
- G NEMA IS 10034 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable Speed Drive Systems; 2022 (Reapproved 2025).
- H NEMA IS 10035 - Application Guide for AC Adjustable Speed Drive Systems; 2021 (Reaffirmed 2025).
- I NEMA MG 00001 - Motors and Generators; 2024.
- J NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems; 2021.
- K NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- M UL 61800-5-1 - Standard for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements – Electrical, Thermal, and Energy (Ed. 2); Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordination:
 - 1. Coordinate work to provide motor controllers suitable for use with actual motors to be installed.
 - 2. Coordinate work to provide controllers and associated wiring suitable for interface with control devices to be installed.

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3. Coordinate arrangement with dimensions and clearance requirements of actual equipment to be installed.
4. Verify with manufacturer that conductor terminations are suitable for use with conductors to be installed.
5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide manufacturer's standard catalog pages and data sheets for motor controllers, enclosures, overcurrent protective devices, and other installed components and accessories.
- C Shop Drawings: Indicate dimensions, voltage, controller sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
 1. Include wiring diagrams showing factory and field connections.
 2. Identify mounting conditions required for equipment seismic qualification.
- D Installer qualification statement.
- E Manufacturer's certification that products meet or exceed specified requirements.
- F Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- G Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

1.06 QUALITY ASSURANCE

- A Comply with requirements of NFPA 70.
- B Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- C Installer Qualifications: Company with minimum three years documented experience with variable-frequency motor control systems of similar size, type, and complexity; manufacturer's authorized installer.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Store in clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B Handle carefully in accordance with manufacturer's written instructions to avoid damage to internal components, enclosure, and finish.

1.08 FIELD CONDITIONS

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

1.09 WARRANTY

- A See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

- B Provide minimum 18 month manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A ABB: www.abb.com/#sle.
- B Danfoss.
- C Yasikawa HV600
- D Source Limitations: Furnish variable-frequency motor controllers and associated components produced by a single manufacturer and obtained from a single supplier.

2.02 VARIABLE-FREQUENCY MOTOR CONTROLLERS

- A Provide variable-frequency motor control system consisting of required controller assemblies, operator interfaces, control power transformers, instrumentation and control wiring, sensors, accessories, system programming, etc. as necessary for complete operating system.
- B Provide products listed, classified, and labeled as suitable for purpose intended.
- C Variable-Frequency Motor Controller:
 - 1. Basis of Design: ABB.
 - 2. Configuration: Packaged controller with across-the-line bypass on all VFD's over 3 HP
 - 3. Rectifier/Converter: Diode-based, 6-pulse type.
 - 4. Control Method: Vector; open-loop, without feedback.
 - 5. Filtering: Provide input/line reactor and output/load reactor.
- D Controller Assemblies: Comply with NEMA IS 10033, NEMA IS 10034, and NEMA ICS 61800-2; list and label as complying with UL 61800-5-1 or UL 508A as applicable.
- E Provide controllers selected for actual installed motors and coupled mechanical loads in accordance with NEMA IS 10035, NEMA MG 00001 Part 30, and recommendations of manufacturers of both controller and load, where not in conflict with specified requirements; considerations include, but are not limited to:
 - 1. Motor type (e.g., induction, reluctance, and permanent magnet); consider NEMA MG 00001 design letter or inverter duty rating for induction motors.
 - 2. Motor load type (e.g., constant torque, variable torque, and constant horsepower); consider duty cycle, impact loads, and high inertia loads.
 - 3. Motor nameplate data.
 - 4. Requirements for speed control range, speed regulation, and braking.
 - 5. Motor suitability for bypass starting method, where applicable.
- F Devices on Load Side of Controller: Suitable for application across full controller output frequency range.
- G Operating Requirements:
 - 1. Input Voltage Tolerance: Plus/minus 10 percent of nominal.
 - 2. Input Frequency Tolerance: Plus/minus 5 percent of nominal.
 - 3. Efficiency: Minimum of 96 percent at full speed and load.
 - 4. Input Displacement Power Factor: Minimum of 0.96 throughout speed and load range.

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5. Overload Rating:
 - a. Variable Torque Loads: Minimum of 110 percent of nominal for 60 seconds.
 - b. Constant Torque Loads: Minimum of 150 percent of nominal for 60 seconds.
- H Power Conversion System: Microprocessor-based, pulse width modulation type consisting of rectifier/converter, DC bus/link, and inverter.
 1. Rectifier/Converter: Diode-based, 6-pulse type unless otherwise indicated.
- I Control System:
 1. Provide microprocessor-based control system for automatic control, monitoring, and protection of motors. Include sensors, wiring, and connections necessary for functions and status/alarm indications specified.
 2. Provide integral operator interface for controller programming, display of status/alarm indications, fault reset, and local control functions including motor run/stop, motor forward/reverse selection, motor speed increase/decrease, and local/remote control selection.
 3. Control Functions:
 - a. Control Method: Selectable vector and scalar/volts per hertz unless otherwise indicated.
 - 1) Scalar/Volts per Hertz Control: Provide IR compensation for improved low-speed torque.
 - 2) Vector Control: Provide selectable autotuning function.
 - b. Adjustable acceleration and deceleration time; linear and S-curve ramps; selectable coast to stop.
 - c. Selectable braking control; DC injection or flux braking.
 - d. Adjustable minimum/maximum speed limits.
 - e. Adjustable pulse width modulation switching carrier frequency.
 - f. Adjustable motor slip compensation.
 - g. Selectable autorestart after noncritical fault; programmable number of time delay between restart attempts.
 - h. Automatic response to loss of speed reference; selectable to run motor at last known speed, run motor at designated speed, or stop motor.
 - i. PID Control: Provide integral PID controller employing feedback for closed-loop control where indicated or required.
 - j. Automatic catching of rotating motor.
 - k. Energy-saving algorithms.
 4. Status Indications:
 - a. Motor run/stop status.
 - b. Motor forward/reverse status.
 - c. Local/remote control status.
 - d. Output voltage.
 - e. Output current.

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- f. Output frequency.
 - g. DC bus voltage.
 - h. Motor speed.
 - i. Speed reference.
- 5. Protective Functions/Alarm Indications:
 - a. Overcurrent.
 - b. Motor overload.
 - c. Undervoltage.
 - d. Overvoltage.
 - e. Controller overtemperature.
 - f. Input/output phase loss.
 - g. Output short circuit protection.
 - h. Output ground fault protection.
- 6. Inputs:
 - a. Digital Input(s): Three.
 - b. Analog Input(s): Two.
- 7. Outputs:
 - a. Analog Output(s): One.
 - b. Relay Output(s): Two.
- 8. Communications: Compatible with connected systems. Provide accessories necessary for proper interface. Coordinate with Controls Contractor.
 - a. Serial Communications: RS-485; support for BACnet MS/TP protocol.
 - b. Ethernet Communications: Support for Modbus TCP and BACnet IP protocol.
 - c. Remote Monitoring Capabilities:
 - 1) Motor run/stop status.
 - 2) Hand-off-auto status.
 - 3) Fault information.
 - 4) Discrete input/output status.
 - 5) Analog input/output values.
 - d. Remote Control Capabilities:
 - 1) Motor run/stop command.
 - 2) Hand-off-auto selection.
 - 3) Speed adjustment.
 - 4) Fault reset.
- 9. Features:
 - a. Password-protected security access.
 - b. Event log.
- J Power Conditioning/Filtering:

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1. Provide DC link choke or input/line reactor for each controller unless otherwise indicated or required.
 2. Reactor Impedance: 3 percent, unless otherwise indicated or required.
- K Packaged Controllers: Controllers factory-mounted in separate enclosure with externally operable disconnect and specified accessories.
1. Disconnects: Circuit breaker or disconnect switch type.
 - a. Disconnect Switches: Fusible type or nonfusible type with separate input fuses.
 - b. Provide externally operable handle with means for locking in OFF position. Provide safety interlock to prevent opening cover with disconnect in ON position with capability of overriding interlock for testing purposes.
 - c. Provide auxiliary interlock for disconnection of external control power sources where applicable.
 2. Provide door-mounted remote operator interface.
 3. Packaged Controllers with Bypass: Provide contactors and controls to enable removal of variable-frequency controller from circuit.
 - a. Bypass Method: Manual, unless otherwise indicated.
 - b. Bypass Configuration: 3-contactor type, with contactors for bypass, drive output, and drive input.
 - c. Bypass Motor Starting Method: Full-voltage (across-the-line) with overload relay, unless otherwise indicated or required.
 - d. Overload Relays: Solid state or bimetallic thermal type.
 4. Pilot Devices Required:
 - a. Furnish local pilot devices for each unit as specified below unless otherwise indicated on drawings, except where equivalent function is provided by remote operator interface.
 - b. Packaged Controllers with Bypass:
 - 1) Bypass Mode Selector Switch: DRIVE/OFF/BYPASS.
 - 2) Motor Control Selector Switch: HAND/OFF/AUTO.
 - 3) Indicating Lights: For drive/bypass mode status, drive/bypass run status, and drive/bypass fault status.
- L Service Conditions:
1. Provide controllers and associated components suitable for operation under following service conditions without derating:
 - a. Altitude: Less than 3,300 feet.
 - b. Ambient Temperature: Between 32 degrees F and 104 degrees F.
 2. Provide controllers and associated components suitable for operation at indicated ratings under service conditions at installed location.
- M Short Circuit Current Rating:
1. Provide line/input reactors where specified by manufacturer for required short circuit current rating.

- N Conductor Terminations: Suitable for use with conductors to be installed.
- O Enclosures:
 - 1. Comply with NEMA IA 10030.
 - 2. NEMA EN 10250 Environment Type or Equivalent IEC 60529 Rating: Unless otherwise indicated, as specified for following installation locations:
 - 3. Finish: Manufacturer's standard unless otherwise indicated.
 - 4. Cooling: Forced air or natural convection as determined by manufacturer.

2.03 OVERCURRENT PROTECTIVE DEVICES

- A Overload Relays:
 - 1. Provide overload relays and, where applicable, associated current elements/heaters selected for actual installed motor nameplate data, in accordance with manufacturer's recommendations and NFPA 70; include consideration for motor service factor and ambient temperature correction, where applicable.
 - 2. Comply with NEMA ICS 2.
 - 3. Inverse-Time Trip Class Rating: Class 20 unless otherwise indicated or required.
 - 4. Trip-free operation.
 - 5. Visible trip indication.
 - 6. Resettable:
 - a. Employ manual reset unless otherwise indicated.
 - b. Do not employ automatic reset with two-wire control.
 - 7. Bimetallic Thermal Overload Relays:
 - a. Interchangeable current elements/heaters.
 - b. Adjustable trip; plus/minus 10 percent of nominal, minimum.
 - c. Trip test function.
 - 8. Solid State Overload Relays:
 - a. Adjustable full load current.
 - b. Phase loss protection.
 - c. Phase imbalance protection.
 - d. Ambient temperature insensitive.
 - e. Thermal memory.
 - f. Trip test function.
 - g. Provide isolated alarm contact.

2.04 VARIABLE FREQUENCY DRIVE SCHEDULE

- A Service
 - 1. Air Handlers, Fans, and Air Moving Devices
 - a. Motors less than 5 HP VFD with no bypass.
 - b. Motor 5 HP and over shall be VFD shal with bypass and means of disconnect.
 - 2. Pumps
 - a. Pump Motors under 5 HP VFD with no bypass

- b. Pump Motors 5 HP and over shall be VFD with bypass and means of disconnect.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A Install products in accordance with manufacturer's instructions.
- B Install in accordance with NEMA IS 10034 and manufacturer's instructions.
- C Do not exceed manufacturer's recommended maximum cable length between controller and motor.
- D Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- E Provide required support and attachment in accordance with Section 23 0529.
- F Install controllers plumb and level.
- G Provide grounding and bonding in accordance with Section 26 0526.
- H Install field-installed devices, components, and accessories.
- I Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- J Set field-adjustable settings of controllers and associated components according to installed motor requirements, in accordance with recommendations of manufacturers of controller and load.

3.03 FIELD QUALITY CONTROL

- A Inspect and test in accordance with NETA ATS, except Section 4.
- B Perform inspections and tests listed in NETA ATS, Section 7.17. Insulation-resistance test on control wiring listed as optional is not required.
- C Packaged Controllers with Bypass: Test for proper operation in both drive and bypass modes.
- D Correct deficiencies and replace damaged or defective controllers or associated components.

3.04 ADJUSTING

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

3.05 CLEANING

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

3.06 CLOSEOUT ACTIVITIES

- A Demonstration: Demonstrate proper operation of controllers to Owner, and correct deficiencies or make adjustments as directed.

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- B Training: Train Owner's personnel on operation, adjustment, and maintenance of controllers and associated devices.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of two hours of training.
 3. Instructor: Manufacturer's authorized representative.
 4. Location: At project site.

3.07 PROTECTION

- A Protect installed controllers from subsequent construction operations.

END OF SECTION 23 0934

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**SECTION 23 0950
GAS DETECTION AND ALARM**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Parking Garage Gas detection monitors and sensor modules
- B Boiler Room Gas detection monitors and alarms

1.02 SUBMITTALS

- A Product Data: For each type of gas monitor, include sensing range in ppm, temperature and humidity range, alarm outputs, display range, furnished specialties, installation requirements, and electric power requirement.
- B Provide Wiring Diagrams: Power, signal, and control wiring.
- C Closeout Submittals: Owner and Maintenance Data.

1.03 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
- B Documents at Project Site: Maintain at project site one copy of manufacturer's instructions, erection drawings, and shop drawings.
- C All Gas detection systems shall comply with UL 2075

1.04 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Manufacturer Warranty: Provide 2-year manufacturer warranty for entire system. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 PARKING GARAGE GAS DETECTION

- A Manufacturers
 - 1. American Gas Safety - Basis of Design
 - 2. Armstrong
 - 3. Belimo
 - 4. Honeywell
- B Control Module UL61010
 - 1. Enclosure: ASA 61 gray enameled 16 gauge steel.
 - 2. Supply Voltage: 120 VAC, 60 Hz.
 - 3. Operating Temperature: -4°F to 104°F.
 - 4. Monitor Warranty: 2 years.
 - 5. Touch Screen Control Panel
 - 6. Relays for activation
 - a. On/Off
 - b. Two Speed
 - c. 0-10Vdc VFD operation
 - 7. Relays shall be provided for pre-alarm, high alarm and full alarm threshold.

8. Provide a damper relay which is configurable to an onsite actuator at a determined threshold.
9. Unit shall accept up to 16 remote sensors.
10. Activated audible alarm shall provide 85 dBA @10ft.
11. BMS output for monitoring.

C Alarm Beacon

1. Provide a dual audible and visual alarm beacon constructed of polycarbonate enclosure with high intensity LED's
2. The alarm shall provide 32 selectable sirens and volume options and 8 flash patterns
3. The beacon shall be powered by the gas detection panel in alarm via 24vdc output.
4. Install on single gang rough in box outside of the protected area.

D Gas Detection Modules.

1. Sensor Modules to be provide by same manufacturer as the control module.
2. Detectable Gasses: Carbon Monoxide & Nitrous Oxide.
3. Power: 24 VAC
4. Sensor Type: Electrochemical.
5. Range: As recommended by manuf. COX & NO2.
6. Sensor Warranty: COX & NO2 – 3 years.
7. Standard trip points: as recommended by manuf. COX & NO2.
 - a. Installation wiring: 3 wire 18 AWG shielded.

E Temperature and Humidity Modules.

1. Sensor Modules to be provide by same manufacturer as the control module.
2. Detection: Temperature and Humidity
3. Power: 24 VAC
4. Sensor Type: Electrochemical.
5. Range: As recommended by manuf. Temperature and RH
6. Sensor Warranty: 3 years.
7. Standard trip points: 50% RH (Adjustable)
 - a. Installation wiring: 3 wire 18 AWG shielded.

2.02 BOILER ROOM GAS DETECTORS AND MONITORS

A Manufacturers:

1. American Gas Safety (AGS) Mini Merlin
2. Belimo
3. Approved Alternatives

- B The device will be 120 Vac powered, individually powered and capable of accepting the inputs of multiple devices. The unit will clearly display the condition of an alarm and provide hazardous or toxic gas levels via ppm or % of VOL. The device shall provide a re-set and test function. The device shall incorporate dual sensor technology to detect Methane and CO (Carbon Monoxide) without the requirement for additional components. The unit shall be UL certified and listed. Mount the panel per manufacturer's instructions and recommendations.

- C The device panel will be capable of transmitting alarm conditions to a BMS system through its dry contact relay output. For local activation of fans or louvers (or other equipment), the relay will change state in alarm and revert back once the alarm has been removed.
- D The device panel will be capable of operating within relative humidity ranges of 5-95% non-condensing and temperature ranges of -4° F to 140° F (-20° C to 60° C).
- E The device will be certified and listed to ANSI/UL 61010-1 3rd edition and CAN/CSA-C22.2 No. 61010-1.
- F The device will energize a 120v output to control gas solenoid valves and electrical contactors. In alarm the device shall de-energize this control output.
- G For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft.
- H The unit shall provide a traffic signal type colored TFT display, Green – all clear, Yellow – warning (low alarm) Red – Alarm.
- I Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:
- J The sensors shall be UL listed to comply with UL2075 and incorporate filters to only look for the desired hazardous or toxic gases selected.
- K Local Building Codes recommendations take precedence over these parameters. Coverage can differ depending on application.
- L Accessories
 - 1. Detector Guards type AGSGUARD. The grid is made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards
 - 2. Remote Panic Button type AGSEBSTW Panic Button will be constructed of tough polycarbonate with a stainless steel back plate capable of operating within relative humidity ranges of 0-100% and temperature ranges of -40° F to 250° F (-40° C to 121° C). Unit will be clearly labeled “EMERGENCY BOILER SHUT-OFF” with 5/8” black text on yellow background with red mushroom type button. Unit will be certified and listed to UL safety standards and be ADA compliant.
 - 3. Gas Valve type AGSGSV (sizes shown on plans) shall be 120v actuated flanged gas solenoid with an operating pressure of 0-5PSI. Constructed of die-cast aluminum with a fluid powered actuator. The valves should be UL listed as a safety shut-off valve with a closing time of <1second.
 - 4. Electric Contactor type AGS4P50ANO shall be 120V energized electrically held normally open contactor providing 4 Poles (circuits) at 50 AMP at 120v 50/60HZ. Contactor shall be UL listed.

2.03 SOURCE QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.

PART 3 EXECUTION

3.01 INSTALLATION

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- A Install in accordance with manufacturer's written instructions. See drawing schedule for basis of design. If alternate manufacturer is provided. Contractor shall provide all modifications necessary to install a fully functional system.
- B Comply with ASHRAE.
- C Install sampling inlets that are accessible to personnel.
- D Wall mount air-sampling multiple-point monitors with top of unit 60 inches above finished floor.
- E Run air-sampling conduit and wire from monitor to air-sampling point, in size as required by monitor manufacturer.
- F Extend air-sampling tubing from exhaust part of multiple-point monitors to outside.
- G Visible Alarm-Indicating Devices: Install adjacent to each alarm horn at each entry door to refrigeration equipment room, and position at least 6 inches
- H The basis of design provides one 120 volt circuit by electrical contractor to the alarm panel. Div 23 contractor to provide all 24 volt wiring and conduit to provide interconnection to all remote sensors and alarms. Any modifications to the basis of design shall be covered by Div. 23

3.02 SYSTEM STARTUP

- 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.
- C Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D Tests and Inspections:
 - 1. Inspect field-assembled components, equipment installation, and electrical connections for compliance with requirements.
 - 2. Test and adjust controls and safeties.
- E Test Reports: Prepare a written report to record the following:
- F Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- G Repair or replace malfunctioning units and retest as specified above.

3.03 CLOSEOUT ACTIVITIES

- A Demonstrate proper operation of equipment to Owner's designated representative.
- B Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Training Reference: Operation and maintenance manual and additional training materials as required.
 - 2. Provide minimum of two hours of training.

END OF SECTION 23 0950

**SECTION 23 1123
FACILITY NATURAL-GAS PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A Section 09 9113 - Exterior Painting.
- B Section 33 5216 - Gas Hydrocarbon Piping.

1.03 REFERENCE STANDARDS

- A ANSI Z21.18/CSA 6.3 - Gas Appliance Pressure Regulators; 2019.
- B ANSI Z21.80/CSA 6.22 - Line Pressure Regulators; 2019.
- C ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- D ASME B31.1 - Power Piping; 2024.
- E ASME B31.9 - Building Services Piping; 2020.
- F ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).
- G ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- H ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- I ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- J MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.
- D Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.05 QUALITY ASSURANCE

- A Perform work in accordance with applicable codes.
- B Valves: Manufacturer's name and pressure rating marked on valve body.
- C Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- D Welder Qualifications: Certified in accordance with ASME BPVC-IX.

- E Identify pipe with marking including size, ASTM material classification, and ASTM specification.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Provide temporary protective coating on cast iron and steel valves.
- B Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

PART 2 PRODUCTS

2.01 NATURAL GAS PIPING, ABOVE GRADE

- A Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.
 - 1. Manufacturers:
 - a. Wheatland Tube Company: www.wheatland.com/#sle.
 - 2. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 3. Joints: Threaded or welded to ASME B31.1.

2.02 GAS RISER AND TRANSITION FITTING

- A PE Pipe: Gastit or Equal
 - 1. All pipe shall meet or exceed the requirements of ASTM D2513 and carry the appropriate pipe category rating. PE pipe shall be IAPMO/UPC and CSA listed where applicable and marked.
- B Protective Casing
 - 1. Steel Tubing per ASTM A513, Minimum wall shall be schedule 40.
- C O Ring shall be Buna-N per ASTM D2000
- D Epoxy Coating shall be electrostatically applied fusion bonded epoxy coating of minimum of 8 mills. Color shall be grey metallic. Cathodic disbondment shall be as per ASTM G8.

2.03 FLANGES, UNIONS, AND COUPLINGS

- A Unions for Pipe Sizes 3 Inches and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.

2.04 PIPE HANGERS AND SUPPORTS

- A Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 - 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 - 4. Vertical Pipe Support: Steel riser clamp.

5. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - a. Bases: High density polypropylene.
 - b. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - c. Steel Components: Stainless steel, or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - d. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion resistant material.
 - e. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.

2.05 BALL VALVES

- A Construction, 3 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder or threaded ends with union.

2.06 STRAINERS

- A Size 2 inch and Under:
 1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
 2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
- B Size 1-1/2 inch to 4 inch:
 1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

2.07 LINE PRESSURE REGULATORS AND APPLIANCE REGULATORS INDICATORS

- A Manufacturers:
 1. Maxitrol Company: www.maxitrol.com/#sle.
- B Compliance Requirements:
 1. Appliance Regulator: ANSI Z21.18/CSA 6.3.
 2. Line Pressure Regulator: ANSI Z21.80/CSA 6.22.
- C Materials in Contact With Gas:
 1. Housing: Aluminum, steel (free of non-ferrous metals).
 2. Seals and Diaphragms: NBR-based rubber.
- D Maximum Inlet Operating Pressure: 5 psi.
 1. Appliance Regulator: 5 psi.
 2. Line Pressure Regulator: 5 psi.
- E Maximum Body Pressure: 10 psi.
- F Output Pressure Range: 7 inch wc to 11 inch wc.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- C Install piping to maintain headroom, conserve space, and not interfere with use of space.
- D Group piping whenever practical at common elevations.
- E Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- F Provide access where valves and fittings are not exposed.
- G Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- H Provide support for utility meters in accordance with requirements of utility companies.
- I Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
 - 1. Painting of exterior piping systems and components is specified in Section 09 9113. Mechanical contractor shall paint exterior piping with 2 coats of rust resistant yellow paint.
- J Install valves with stems upright or horizontal, not inverted.
- K Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
- L Sleeve pipes passing through partitions, walls and floors.
- M Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.

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9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.04 APPLICATION

- A Install unions downstream of valves and at equipment or apparatus connections.
- B Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

3.05 SERVICE CONNECTIONS

- A Mechanical Contractor shall provide, coordinate, and pay for all utility costs for new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 2 psi. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.06 SCHEDULES

- A Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inches to 1-1/4 inches:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inches to 2 inches:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION 23 1123

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**SECTION 23 2113
HYDRONIC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Hydronic system requirements.
- B Heating/Cooling water and glycol piping, buried.
- C Heating/Cooling water and glycol piping, above grade.
- D Chilled water piping, Exterior .
- E Radiant heating piping system.
- F Equipment drains and overflows.
- G Pipe hangers and supports.
- H Unions, flanges, mechanical couplings, and dielectric connections.
- I Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
- J Flow controls.

1.02 RELATED REQUIREMENTS

- A Section 08 3100 - Access Doors and Panels.
- B Section 09 9123 - Interior Painting.
- C Section 23 0719 - HVAC Piping Insulation.
- D Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- B ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- C ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- D ASME B31.9 - Building Services Piping; 2020.
- E ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).
- F ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- G ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- H ASTM A536 - Standard Specification for Ductile Iron Castings; 2024.
- I ASTM B32 - Standard Specification for Solder Metal; 2020.
- J ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- K ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- L ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.

- M ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2024).
- N AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- O AWS D1.1/D1.1M - Structural Welding Code - Steel; 2020, with Errata (2023).
- P AWWA C606 - Grooved and Shouldered Joints; 2022.
- Q MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- E Project Record Documents: Record actual locations of valves.
- F Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum 5 years of experience.
- C Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- D Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. A distributor's representative is not considered qualified to perform the training.

1.07 DELIVERY, STORAGE, AND HANDLING

- A Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B Provide temporary protective coating on cast iron and steel valves.
- C Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

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

1.08 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Engineer.
 - b. Use rigid joints unless otherwise indicated.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For throttling, bypass, or manual flow control services, use globe, ball, or butterfly valves.
 - 4. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.

2.02 HEATING/CHILLED WATER AND GLYCOL PIPING, ABOVE GRADE

- A Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 - 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B Copper Tube: ASTM B88 (ASTM B88M), Type M (C), drawn, using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

- b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
- 2. Grooved Joints: AWWA C606 grooved tube, fittings of same material, and copper-tube-dimension mechanical couplings.
- 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.03 CHILLED WATER PIPING, EXTERIOR

- A Manufacturer
 - 1. PermaPipe Xtru Therm with UV Above Grade Exterior Protective Coating
- B Carrier Pipe Steel Pipe: ASTM A53/A53M, Schedule 40, black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type with double layer, half-lapped polyethylene tape.
 - 2. Joints: Welded in accordance with AWS D1.1/D1.1M.
- C Insulation
 - 1. Polyurethane Foam 90% Closed Cell
 - 2. Density: 2 lbs/ cubic Foot
 - 3. Minimum Thickness: 1" Thru 12" diameter
 - 4. Free of any voids
- D Exterior Insulation Jacket
 - 1. High Density Polyethylene (HDPE) in accordance with ASTM D3350
 - 2. Thickness: 0.10" Minimum Thickness Thru 12"
 - 3. Provide Exterior Rated UV Coating
- E Fittings and Joints
 - 1. Provide factory prefabricated and pre-insulated joints and fittings.
- F Field Joints
 - 1. All Field joints shall be provided and inspected by manufacturer.

2.04 RADIANT HEATING PIPING

- A Copper Tube: ASTM B88 (ASTM B88M), Type L (B) annealed.
 - 1. Fittings: ASME B16.22, wrought copper.
 - 2. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.

2.05 GROOVEED MECHANICAL JOINTS AND COUPLINGS

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Anvil.
 - 2. Victaulic Company
- B Source Limitations: Obtain grooved mechanical-joint fittings and couplings from single manufacturer.
- C Warranty:
 - 1. Removal and Replacement of all items leaking or found defective for a period of 10 years.

- D Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- E Couplings: Rigid Type Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 1. Temperature Limitations: 230 Degrees F
 - 2. All Gaskets shall be compatible with fluid type and capable of glycol concentrations of up to and including 50%

2.06 EQUIPMENT DRAINS AND OVERFLOWS

- A Copper Tube: ASTM B88 (ASTM B88M), Type M (C), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.07 PIPE HANGERS AND SUPPORTS

- A Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
 - 8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 9. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
 - 10. Wall Support for Hot Pipe Sizes 6 Inches and Greater: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
 - 11. Vertical Support: Steel riser clamp.
 - 12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 14. Floor Support for Hot Pipe Sizes 6 Inches and Greater: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
 - 15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

16. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.08 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A Unions for Pipe of 2 Inches and Less:
 - 1. Ferrous Piping: 150 psi brass or malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick, preformed neoprene.
- C Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 - 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F. Gasket shall be capable of 50% concentrations of EG or PG glycol solutions
 - 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - 7. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. Victaulic Company: www.victaulic.com/#sle.
 - 8. Warranty
 - a. Provide all the labor and material to remove and replace all defective or leaking components. Warranty shall cover damage to materials and finishes for a period of 10 years.

2.09 BALL VALVES

- A Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
 - 4. Victaulic Company: www.victaulic.com/#sle.
- B Up To and Including 2 Inches:
 - 1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C Over 2 Inches:
 - 1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle, flanged ends, rated to 800 psi.

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2.10 BUTTERFLY VALVES

- A Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
 - 4. Victaulic Company: www.victaulic.com/#sle.
- B Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D Operator: 10 position lever handle.

2.11 SWING CHECK VALVES

- A Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Apollo Valves: www.apollovalves.com/#sle.
 - 3. Grinnell Products: www.grinnell.com/#sle.
 - 4. Victaulic Company: www.victaulic.com/#sle.
- B Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
- C Over 2 Inches:
 - 1. Iron body, bronze trim, stainless steel, bronze, or bronze faced rotating swing disc, renewable disc and seat, flanged or grooved ends.

2.12 SPRING LOADED CHECK VALVES

- A Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Victaulic Company: www.victaulic.com/#sle.
- B Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.13 FLOW CONTROLS

- A Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - 3. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 4. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 5. Taco, Inc: www.taco-hvac.com/#sle.
 - 6. Victaulic Company: www.victaulic.com/#sle.
 - 7. Nexus
- B Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

- C Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C Install piping to conserve building space and to avoid interference with use of space.
- D Group piping whenever practical at common elevations.
- E Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- F Slope piping and arrange to drain at low points.
- G Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- H Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 2-inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Provide copper plated hangers and supports for copper piping.
 - 9. Prime coat exposed steel hangers and supports. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

- I Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 0719.
- J Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 3100 .
- K Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- L Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. See Section 09 9123.
- M Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A Hanger Spacing for Copper Tubing.
 - 1. As Per manufacturers recommendations or as stated below.
 - 2. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 3. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 4. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. 3 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 7. 4 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.
 - 8. 6 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- B Hanger Spacing for Steel Piping.
 - 1. 1/2 Inch to 1 1/2" Inch, Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 2. 2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 3. 2-1/2 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
 - 4. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 - 5. 4 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.
 - 6. 6 Inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION 23 2113

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**SECTION 23 2114
HYDRONIC SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Expansion tanks.
- B Air vents.
- C Air separators.
- D Strainers.
- E Suction diffusers.
- F Combination pump discharge valves.
- G Pressure-temperature test plugs.
- H Balancing valves.
- I Automatic flow control valves.
- J Relief valves.
- K Glycol system.

1.02 RELATED REQUIREMENTS

- A Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023, with Errata (2024).
- B ASTM D2774 - Standard Practice for Underground Installation of Thermoplastic Pressure Piping; 2021a.
- C ASTM F2389 - Standard Specification for Pressure-Rated Polypropylene (PP) Piping Systems; 2023.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
- C Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- D Project Record Documents: Record actual locations of flow controls.
- E Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

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

- B Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS**2.01 EXPANSION TANKS**

- A Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com/#sle.
 - 2. Armstrong
 - 3. Bell & Gossett, a brand of Xylem, Inc; DIAPHRAM D SERIES:
www.bellgossett.com/#sle.
 - 4. Taco, Inc: www.taco-hvac.com/#sle.
 - 5. Grundfos.
- B Acceptance Volume Capacity: As indicated on drawings.
- C Maximum Rated Working Pressure: 125 psi.
- D Maximum Allowable Service Temperature: 240 degrees F.
- E Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, adjustable flexible butyl diaphragm or bladder seal factory precharged to 12 psi, and steel support stand.
- F Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.
- G Accessories: Provide air-charging fitting, bulls eye sight glass, pressure gauge, and tank drain ball valve.

2.02 AIR VENTS

- A Manual Air Vent: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- B Float Air Vent:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- C Maximum Fluid Pressure: 150 psi.
- D Maximum Fluid Temperature: 250 degrees F.

2.03 AIR SEPARATORS

- A Coalescing Air/Dirt Separators:
 - 1. Manufacturers:
 - a. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 - b. Spirotherm, Inc: www.spirotherm.com/#sle.
 - c. Taco
 - d. Caleffi

2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1 for maximum fluid service subject to application requirements and manufacturer's standard maximum operating conditions.
3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to top of separator.
5. End Connections: Class 150 flanged for 2-1/2 inch and larger otherwise threaded.
6. Blowdown Connection: Threaded.
7. Size: Match system flow capacity.
8. Maximum Fluid Service Pressure: 150 psi.
9. Maximum Fluid Service Temperature: 250 degrees F.
10. Accessories: Provide epoxy coating finish, removable strainer, and tank-bottom magnets.

2.04 STRAINERS

A Size 2 inch and Under:

1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.
2. Body Material by Fluid Service:
 - a. Cast Iron or Brass:
 - 1) Steam: Up to 250 psi at 450 degrees F.
 - 2) Liquids: Up to 400 psi at 150 degrees F.

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

1. Provide flanged or grooved iron body for up to 175 psi working pressure, up to 250 degrees F working temperature, Y-pattern strainer with 1/16 inch or 3/64 inch stainless steel perforated screen.
2. Body Material by Fluid Service:
 - a. Cast Iron:
 - 1) Steam: Up to 125 psi at 350 degrees F.
 - 2) Liquids: Up to 200 psi at 150 degrees F.

2.05 SUCTION DIFFUSERS

A Manufacturers:

1. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
2. Victaulic Company of America: www.victaulic.com/#sle.
3. Taco
4. Grundfos

- B Fitting:** Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.

C Class 125:

1. Horizontally or vertically mounted angle-pattern fitting with integral-cast vanes, fine particle mesh screen and magnetic drain plugs for particle removal without disassembly.
2. Maximum Operating Service: 175 psi and 300 degrees F.
3. Sizes, Material, and Connection:
 - a. 2 inch and Smaller: Cast iron body, threaded.
 - b. 2-1/2 to 12 inch: Ductile iron body, flanged.

D Class 150, Size 1-1/2 to 4 inch:

1. Angle-pattern flanged carbon steel fitted with integral vanes, removable strainer, and magnetic drain plugs for particle removal without disassembly.
2. Maximum Operating Service:
 - a. Class 150: 150 psi at 450 degrees F.

E Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

A Manufacturers:

1. The Metraflex Company; Vane Flex: www.metraflex.com/#sle.
2. Engineered Flexible Products.
3. Twin City Hose
4. Grundfos

B Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.

1. Maximum Operating Service: 150 psi at 120 degrees F.
2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion:
 - b. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.
4. Provide pump connector with integral vanes to reduce turbulent flow.
5. Provide necessary accessories including, but not limited to, swivel joints.

2.07 COMBINATION PUMP DISCHARGE VALVES

A Manufacturers:

1. Crane Co.: www.craneco.com/#sle.
2. Taco, Inc: www.taco-hvac.com/#sle.
3. Victaulic Company of America: www.victaulic.com/#sle.
4. Bell and Gossett.
5. Grundfos

B Quarter-Turn Plug Type: Flanged cast-iron body with bolt-on bonnet, position indicator, stainless steel stem, backflow preventer, memory stop, metering connectors, bubble-tight shutoff, and wrench-adjustable plug flow regulator.

- C Triple-Duty Globe Type: Grooved cast-iron angle pattern body with bolt-on bonnet, position indicator, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, metering connectors, flow shutoff mechanism, and adjustable flow handle.

2.08 PRESSURE-TEMPERATURE TEST PLUGS

- A Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- B Application: Use extended length plugs to clear insulated piping.

2.09 BALANCING VALVES

- A Manufacturers:
1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 3. FNW: www.fnw.com/#sle.
 4. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 5. Nexus Valve, Inc: www.nexusvalve.com/#sle.
 6. Gerand Engineering
 7. Griswold Controls
 8. Pro Hydronics
 9. Hydronic Components Inc.
- B Size 2 inch and Smaller:
1. Provide ball or globe style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and female sweat, NPT threaded, press, or soldered connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon or EPDM.
 4. Maximum Service Operation: 300 psi at 250 degrees F.
- C Size 2-1/2 inch and Larger:
1. Provide ball, globe, or butterfly style with flow balancing, shut-off capabilities, memory stops, and minimum of two metering ports and flanged, grooved, or weld-end connections.
 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, or EPDM.
 4. Maximum Service Operation: 175 psi at 250 degrees F.

2.10 AUTOMATIC FLOW CONTROL VALVES

- A Manufacturers:
1. Armstrong International: www.armstronginternational.com/#sle.
 2. Bell & Gossett, a brand of Xylem, Inc: www.bellgossett.com/#sle.
 3. Hays Fluid Controls; Mesurflo Balancing Valve: www.haysfluidcontrols.com/#sle.
 4. Nexus Valve, Inc: www.nexusvalve.com/#sle.
 5. Gerand Engineering
 6. Griswold Controls

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7. Pro Hydronics
 8. Hydronic Components Inc.
 9. Taco Inc: www.taco-hvac.com/#sle.
- B Construction:
1. Brass, bronze, or iron body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
 2. Built-in lug-type outlet butterfly valve with 2-position handle.
- C Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- D Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.
- E Size: Match system flow capacity.
- F Accessories: Provide hanging tag, inlet in-line strainer, outlet ball valve, and PT test plug extension.

2.11 RELIEF VALVES

- A Manufacturers:
- B Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.
- C Steam Relief at Maximum Vessel Pressure: 30 psi.

2.12 GLYCOL SYSTEM

- A Manufacturers:
1. Axiom.
- B Side Stream Filter Assembly Axiom SFP-20 or Equal
1. Hydronic Filter Package shall include the following.
 2. 20" Stainless Steel Filter Housing with 0.8 Gallon Volume
 3. Sight Flow Indicator
 4. Isolation Ball Valves
 5. Pressure Relief Valve and Drain
 6. Twenty 25 micron filters
 7. Manual Balancing Valve
- C Packaged Hydronic System Feeder: Axiom SF-10HP or equal
1. Storage: 55 gal polypropylene tank with bolt-removable hinged solid cover and enamel coated carbon steel tank-stand.
 2. Pump:
 - a. Thermally protected 1/4 hp motor at 115 to 120 VAC, single phase rated for indoor service.
 - b. Maximum Service Operation: 100 psi at 85 degrees F.
 3. Mechanical Accessories: System isolation valves, strainer, and pressure gauges.
 4. Flexible connection hose with check valve

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5. Control Panel:
 - a. Plug in single-point system connection rated at 115 to 120 VAC, single phase.
 - b. Interface: Hand switches with indicating lights for ON, FAULT, and LOW LEVEL.
 - c. Pressure Switch: Panel-mounted and prewired for 10 psi cut-in and 40 psi cut-out, adjustable.
 - d. Low Level Cut-Off Switch: Prewired to shut-down unit upon activation. Tank-side mounted.
 - e. Auxiliary Dry Contacts: Low level, high level, and fault/alarm for remote monitoring.
 - f. Alarm: Audio-visual device with panel-mounted silencing switch to activate upon system fault or alarm with audio pressure level rated for 90 dB.
6. Pressure Relief Valve: System-mounted brass valve tubed from pump discharge side into tank with adjustable setpoint between 20 psi and 150 psi.
- D Glycol Solution: Ethylene Glycol - Dow Chemical Company
 1. Water-based solution mix containing 35 percent ethylene glycol by volume required for cooling or heating system operating temperature range.
 2. Cooling or heating System Operating Temperature Range: Between freezing and boiling points of -30 and 225 degrees F at 14.7 psia.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install specialties in accordance with manufacturer's instructions.
- B Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C Provide manual air vents at system high points and as indicated.
- D Provide air separator on suction side of system circulation pump and connect to expansion tank.
- E Provide valved drain and hose connection on strainer blowdown connection.
- F Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- G Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- H Support pump fittings with floor-mounted pipe and flange supports.
- I Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- J Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- K Pipe relief valve outlet to nearest floor drain or to glycol recovery tank
- L Clean and flush glycol system before adding glycol solution, see Section 23 2500.
- M Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- N Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 20 psi.

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- O Perform tests determining strength of glycol and water solution and submit written test results.
- P Provide Autoflow Devices for the following
 - 1. VAV Terminal Units
 - 2. Chilled Beams
 - 3. Unit Heaters
- Q Provide Manual Balancing Valve Assemblies for the following
 - 1. Air Handling Units
 - 2. Cabinet Unit Heaters
 - 3. Branch Circuits
 - 4. Anything Not listed

3.02 MAINTENANCE

- A See Section 01 7000 - Execution Requirements for additional requirements relating to maintenance service.
- B Provide service and maintenance of glycol system for one year from date of Substantial Completion at no extra charge to Owner.
- C Perform Quarterly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Report findings in detail in writing, including analysis and amounts of glycol or water added.
- D Explain corrective actions to Owner's maintenance personnel in person.

END OF SECTION 23 2114

**SECTION 23 2123
HYDRONIC PUMPS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A In-line pumps.
- B End-suction pumps.

1.02 RELATED REQUIREMENTS

- A Section 23 0513 - Common Motor Requirements for HVAC Equipment.
- B Section 23 0934 - Variable-Frequency Motor Controllers for HVAC.

1.03 REFERENCE STANDARDS

- A IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications; 2020 (Corrigendum 2022).
- B NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C UL 778 - Standard for Motor-Operated Water Pumps; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- E Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- F Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Cartridges for Side-Stream Filters: 1 Case for size of filter (Minimum 20).
 - 3. Provide pumps with standard seals for fluhing and filling. Remove the seals and repalce seals with gylcol rated seals after the system has been cleand and filled with gylcol. Provide one extra set of seals for owner after system is operational.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Armstrong Fluid Technology, Inc: www.armstrongfluidtechnology.com/#sle. **Non integrated VFD pumps only.**
- B Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.
- C Grundfos Pumps Corporation: www.grundfos.com/#sle.
- D Taco.

2.02 GENERAL

- A Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B Minimum Quality Standard: UL 778.
- C Base Mounted Pumps: Aligned by qualified millwright.
- D Electrical Requirements:
 - 1. Listed and classified by UL or testing agency acceptable to authority having jurisdiction as suitable for the purpose specified and indicated.
 - 2. Variable Frequency Drives (VFDs): Provide in accordance with Section 23 0934, except for integral-VFDs.
 - 3. Enclosures: Provide unspecified product(s) required to fit motor:

2.03 IN-LINE PUMPS

- A Closed-Coupled, Single-Stage Pump: Vertical pump with radially- or horizontally-split casing; rated for discharge pressures up to 175 psi.
- B Casing: Cast iron with seal flush connection, threaded suction, and discharge ports with gauge port and drain plug.
- C Impeller: Bronze, fully enclosed, keyed directly to motor shaft or extension.
- D Shaft: Carbon steel with stainless steel impeller cap screw or nut and bronze sleeve.
- E Seal: Mechanical seal, 225 degrees F maximum continuous duty temperature.
- F Electrical:
 - 1. Motor: 3600 RPM ECM
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
 - 3. Integral Controls: See Pump Schedule for VFD location and configuration
 - a. Variable Frequency Drive (VFD): Factory-fitted and tested with dedicated terminal box for power, instrumentation and related control wiring.
 - b. DDC Controller: VFD-integrated or external controller module with visual-tactile interface and minimum of 2 analog inputs, 2 digital inputs, and real-time clock. Provide differential pressure sensor and temperature sensor with thermowell and thermal grease.
 - c. BAS, SCADA, or Other Integrated Automation Link: Wi-Fi in accordance with IEEE 802.11.
 - d. Provide separate power circuit and do not power pump through boiler. Power to pump must be maintained to maintain integral vfd programming.

2.04 END-SUCTION PUMPS

- A Split-Coupled Pump: Base-mounted, single-stage pump with horizontal shaft and radially- or horizontally-split casing rated for discharge pressures up to 175 psi.
- B Casing: Cast iron or ductile iron with renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction, and discharge flanged connections with gauge ports.
- C Impeller: Stainless steel, balanced, fully enclosed, keyed to shaft.

- D Bearings: Oil lubricated roller or ball bearings.
- E Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F Seal: Mechanical, 225 degrees F maximum continuous duty temperature with glycol percentages of up to 50%
- G Drive: Flexible coupling with coupling guard.
- H Baseplate: Cast iron or fabricated steel with integral drain rim.
- I Electrical:
 - 1. Motor: 1,750 rpm, total-enclosed, fan-cooled (TEFC); see Section 23 0513.
 - 2. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D Provide line sized shut-off valve and strainer on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- E Provide drains for bases and seals, piped to and discharging into floor drains.
- F Lubricate pumps before start-up.
- G Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tapings.

END OF SECTION 23 2123

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**SECTION 23 2500
HVAC WATER TREATMENT**

HVAC WATER TREATMENT

PART 1 GENERAL

2.01 SUMMARY

- A This Section includes the following HVAC water-treatment systems:
 - 1. Chemical treatment test equipment.
 - 2. HVAC water-treatment chemicals.

2.02 PERFORMANCE REQUIREMENTS

- A Perform a water quality analysis at the start of the project to determine the quality and strength of the existing glycol system. Failure to complete this sample and provide to the construction team and design team will result in the Bid Package 2 contractor taking full responsibility for the entire glycol loop.
- B The intent is to match the chemical manufacturer and ensure the final system reaches a minimum of 35% solution.
- C Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- D Closed hydronic systems, including hot-water heating chilled water dual-temperature water and glycol cooling, shall have the following water qualities:
 - 1. pH: Maintain a value within 9.0 to 10.5.
 - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 3. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - 4. Soluble Copper: Maintain a maximum value of 0.20 ppm.
 - 5. TDS: Maintain a maximum value of 10 ppm.
 - 6. Ammonia: Maintain a maximum value of 20 ppm.
 - 7. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
 - 8. Glycol % - 35% Ethylene Glycol.
- E Product Data: For each type of product indicated.
- F Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power and control wiring.
- G Field quality-control test reports.
- H Other Informational Submittals:
 - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
 - 2. Water Analysis: Illustrate water quality available at Project site.

3. Passivation Confirmation Report: Verify passivation of galvanized-steel surfaces, and confirm this observation in a letter to Architect.

2.03 QUALITY ASSURANCE

- A HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section. Minimum of 5 years experience.
- B System will be rejected unless glycol has been tested and is clear for 2 months after substantial completion. It's the installing contractors responsibility for coordination and installation of all chemical flushing and final filling. Rejection of glycol system required complete removal and replacement of the fluid system.
- 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.

PART 2 PRODUCTS

3.01 CHEMICALS

- A Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.
- B Dow Chemical Company or approved equal.

PART 3 EXECUTION

4.01 WATER ANALYSIS

- A Untreated domestic water is not approved for use. Chemical Contractor may provide own distilled or RO water to site or may provide filtration system on site to provide RO or Distilled water to glycol solution. Glycol premix is also approved in 400 gallon and larger totes.
- B Complete water analysis every quarter for the first year.

4.02 INSTALLATION

- A Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.
- B Bypass Feeders: Install in closed hydronic systems, including hot-water heating chilled water dual-temperature water and glycol cooling, and equipped with the following:
 1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
 2. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
 3. Install a swing check on inlet after the isolation valve.

4.03 CONNECTIONS

- A Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B Install piping adjacent to equipment to allow service and maintenance.
- C Install shutoff valves on HVAC water-treatment equipment inlet and outlet.

4.04 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. Inspect field-assembled components and equipment installation, including piping and electrical connections.
 - 2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
 - 3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
 - 4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
 - 5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
 - 7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
 - 8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 23 2500

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**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Metal ducts.
- B Flexible ducts.
- C Air plenums and casings.
- D Ductwork painting.

1.02 RELATED REQUIREMENTS

- A Section 07 8400 - Firestopping.
- B Section 23 0713 - Duct Insulation: External insulation and duct liner.
- C Section 23 3300 - Air Duct Accessories.
- D Section 23 3600 - Air Terminal Units.
- E Section 23 3700 - Air Outlets and Inlets: Fabric air distribution devices.

1.03 REFERENCE STANDARDS

- A ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- C ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- D 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).
- E ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- F NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- G NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.
- H SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- I UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data for duct materials.
- C Provide the following information in chart form for each of the pressure classes in paragraph 2.1.
 - 1. Duct Dimension
 - 2. SMACNA Reinforcement Code
 - 3. Duct Gauge
 - 4. Longitudinal seams

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- 5. Duct lengths
- 6. Reinforcement Spacing.
- 7. Traverse joints
- 8. Mid Joint Reinforcement
- 9. Tie Rod Placement code
- 10. Seal Class.
- D Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.
- E Manufacturer's Certificate: Certify that installation of glass fiber ductwork meets or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.
- B Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of documented experience.

1.06 FIELD CONDITIONS

- A Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B Duct Shape and Materials - Primary Ice Arena Areas and as indicated on plans.
 - 1. Round: Plus or minus 2 in-wc of Aluminum.
 - 2. Rectangular: Plus or minus 2 in-wc of Aluminum.
 - 3. Flat Oval: Plus 2 in-wc of Aluminum.
- C Duct Shape and Materials - Chemical Storage and Ammonia Room and as noted
 - 1. Round: Plus or minus 4 in-wc of CPVC
 - 2. Rectangular: Plus or minus 2 in-wc of G90 PVC coated galvanized steel.
- D Duct Shape and Material in accordance with Allowed Static Pressure Range: General Mechanical Areas
 - 1. Round: Plus or minus 4 in-wc of galvanized steel.
 - 2. Rectangular: Plus or minus 3 in-wc of galvanized steel.
 - 3. Flat Oval: Plus 3 in-wc of galvanized steel.
 - 4. Flexible Duct (Fabric and wire): Plus or minus 2 in-wc; see Section 23 3700.
- E Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Low Pressure Service: Below 2 in-wc: Units with External Static Below 1" ESP on Supply and Return
 - a. Seal: Class C, apply to seal off transverse joints.
 - b. Leakage:
 - 1) Rectangular: Class 24 or 24 cfm/100 sq ft.

- 2) Round: Class 12 or 12 cfm/100 sq ft.
- 2. Low Pressure Service: From 2 in-wc to 3 in-wc: Units with ESP above 1" static pressure and below 2.25
 - a. Seal: Class B, apply sealing of transverse joints and longitudinal seams.
 - b. Leakage:
 - 1) Rectangular: Class 12 or 12 cfm/100 sq ft.
 - 2) Round: Class 6 or 6 cfm/100 sq ft.
- 3. Medium and High Pressure Service: Above 3 in-wc:
 - a. Seal: Class A, apply sealing of transverse joints, longitudinal seams, and duct wall penetrations.
 - b. Leakage:
 - 1) Rectangular: Class 6 or 6 cfm/100 sq ft.
 - 2) Round: Class 3 or 3 cfm/100 sq ft.
- F Duct Fabrication Requirements:
 - 1. Minimum gauge for all ductwork is 26 gauge.
 - 2. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 3. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class. Minimum Gauge for all ductwork shall be 26 gauge.
 - 4. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
 - 5. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
 - 6. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

- A Material Requirements:
 - 1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
 - 2. Aluminum: ASTM B209/B209M, aluminum sheet, alloy 3003-H14.
 - 3. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- B Metal Duct Coating Requirements:
- C Rectangular Double Wall Metal Duct: (Exterior Use and as noted on plans.)
 - 1. Rectangular Double Wall Insulated: Rectangular spiral lock seam duct with galvanized steel outer wall, Solid galvanized steel inner wall; fitting with the solid inner wall. Provide Perforated inner wall as noted on plans for noise control

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- a. Connectors
 - 1) TDC flange
 - b. Insulation:
 - 1) Thickness: 2 inch.
 - 2) Material: Rigid Insulation.
 - 3) Insulation K Value: R-12.
 - 4) Insulation Density: 3# Cu Ft..
 - 5) Joints: TDC - Traverse Duct Connection
 - 6) Pressure Class - 3" Positive / Negative
 - c. Manufacturers:
 - 1) Sheet Metal Connectors.
 - 2) Pro-R.
 - 3) McGill Airflow LLC.
 - 4) ThermaDuct
- D Round Metal Ducts:
- 1. Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
 - 2. Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall for interior applications and solid wall for exterior applications unless noted otherwise. fittings with the solid inner wall.
 - a. Connectors
 - 1) Double wall pipe connector up to 26"
 - 2) Flanged 26" and above.
 - b. Insulation:
 - 1) Thickness: 1 inch.
 - 2) Material: Fiberglass.
 - 3) Insulation K Value: R-6 Interior Applicationsl R-12 Exterior Applications.
 - c. Manufacturers:
 - 1) Ductmate Industries.
 - 3. Round Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
 - a. Manufacturers:
 - 1) Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
- E Round Spiral Duct:
- 1. Round spiral lock seam duct with galvanized steel outer wall.
- F Connectors, Fittings, Sealants, and Miscellaneous:
- 1. Fittings: Manufacture with solid inner wall of perforated galvanized steel.
 - 2. Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
 - 3. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.

- a. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
- b. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
4. Gasket Tape:
 - a. Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
5. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

2.03 FLEXIBLE DUCTS

- A Flexible Ducts: UL 181, Class 1, polyethylene film, mechanically fastened and rolled using galvanized steel to form spiral helix.
 1. Insulation: R6 insulation with polyethylene vapor barrier film.
 2. Pressure Rating: 10 in-wc positive and 2 in-wc negative.
 3. Maximum Velocity: 5500 fpm.
 4. Temperature Range: Minus 20 degrees F to 250 degrees F.

2.04 AIR PLENUMS AND CASINGS

- A Fabricate in accordance with SMACNA (DCS) for indicated operating pressures indicated.
- B Minimum Fabrication Requirements:
 1. Fabricate acoustic plenum or casing with reinforcing turned inward.
 2. Provide 16-gauge, 0.059-inch sheet steel back facing and 22-gauge, 0.029-inch perforated sheet steel front facing with 3/32 inch diameter holes on 5/32 inch centers.
 3. Construct panels 3 inches thick, packed with 4.5 pcf minimum glass fiber insulation media, on inverted channel of 16-gauge, 0.059-inch sheet steel.
 4. Mount floor-mounted plenum or casings on 4-inch high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18-gauge, 0.052-inch expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.
- C Access Doors:
 1. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
 2. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles.
 3. Provide clear wire glass observation ports, minimum 6 by 6 inch size.
- D Thermal Panels:
 1. Material: Steel-faced composite panel with noncombustible structural high density mineral fiber core for plenum fabrication.
 - a. Facing: Galvanized steel (G90), 24 gauge, 0.0275 inch.
 - b. Finish: Unpainted.

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- c. Core: Mineral wool board.
- d. Structural: Nonload bearing.
- 2. Panel Thickness: 2.5 inches.
- 3. R-Value: 12 when tested in accordance with ASTM C177.

PART 3 EXECUTION**3.01 INSTALLATION**

- A Install, support, and seal ducts in accordance with SMACNA (DCS).
- B Install products following the manufacturer's instructions.
- C Comply with safety standards NFPA 90A and NFPA 90B.
- D During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- E Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F Flexible Ducts: Connect to metal ducts with draw bands.
- G Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- H Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with a crimp in the direction of airflow.
- J Connect terminal units to supply ducts directly or with 3 feet maximum length of flexible duct. Do not use flexible duct to change direction.
- K Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp. Do not use flexible duct to change direction.
- L Set plenum doors at 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
- M At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- N Plenums and Casings:
 - 1. Mount floor-mounted casings on 4 inch high concrete curbs.
- O Fire Partitions: Provide firestopping sealing. See Section 07 8400.
- P Duct Accessories, Terminal Units, Inlets, and Outlets: Interconnect as indicated in Sections 23 3300, 23 3600, and 23 3700.
- Q Duct Insulation: Provide duct insulation. See Section 23 0713.

3.02 PAINTING

- A All ductwork outside the ice arenas shall be painted by the General Contractor. All ductwork in these areas shall be provided with paint grip finish, suitable for painting. Ductwork shall meet ASTM 653 for base metal and coating, and requirements for oil free surface prep.

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- B Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

END OF SECTION 23 3100

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**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Air turning devices/extractors.
- B Backdraft dampers - metal.
- C Combination fire and smoke dampers.
- D Combination fire and smoke dampers - corridor dampers.
- E Duct access doors.
- F Duct test holes.
- G Fire dampers.
- H Flexible duct connectors.
- I Volume control dampers.
- J Low leakage (Class 1A) control dampers.
- K Miscellaneous Products:
 - 1. Flexible Duct Elbow Support

1.02 RELATED REQUIREMENTS

- A Section 23 3100 - HVAC Ducts and Casings.

1.03 REFERENCE STANDARDS

- A NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- B NFPA 92 - Standard for Smoke Control Systems; 2021, with Amendment.
- C SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- D UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- E UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- F UL 555C - Standard for Safety Ceiling Dampers; Current Edition, Including All Revisions.
- G UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
- C Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
- D Project Record Drawings: Record actual locations of access doors and test holes.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A Manufacturers:
 1. Greenheck
 2. Krueger-HVAC, Division of Air System Components: www.krueger-hvac.com/#sle.
 3. Ruskin Company: www.ruskin.com/#sle.
 4. Titus HVAC, a brand of Johnson Controls: www.titus-hvac.com/#sle.
- B Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

- A Manufacturers:
 1. Greenheck
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 3. Nailor Industries, Inc: www.nailor.com/#sle.
 4. Pottorff: www.pottorff.com/#sle.
 5. Ruskin Company: www.ruskin.com/#sle.
 6. United Enertech: www.unitedenertech.com/#sle.
- B Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- C Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

- A Manufacturers:
 1. Greenheck
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 3. Nailor Industries, Inc: www.nailor.com/#sle.
 4. Pottorff: www.pottorff.com/#sle.
 5. Ruskin Company: www.ruskin.com/#sle.
 6. United Enertech: www.unitedenertech.com/#sle.
- B Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C Provide factory sleeve and collar for each damper.
- D Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.

- E Operators: UL listed and labeled; spring-return, electric-type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.
- G Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.04 COMBINATION FIRE AND SMOKE DAMPERS - CORRIDOR DAMPERS

- A Manufacturers:
 - 1. Greenheck
 - 2. Pottorff
 - 3. Ruskin Company: www.ruskin.com/#sle.
 - 4. United Enertech: www.unitedenertech.com/#sle.
- B Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- C Provide factory sleeve and collar for each damper.
- D Multiple Blade Dampers: Fabricate with 16 gauge, 0.0598 inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E Operators: UL listed and labeled; spring-return, electric type suitable for 120 volts, single phase, 60 Hz. Provide end switches to indicate damper position. Locate damper operator on interior of duct and link to damper operating shaft.
- F Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.
- G Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.05 DUCT ACCESS DOORS

- A Manufacturers:
 - 1. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 - 2. Nailor Industries, Inc: www.nailor.com/#sle.
 - 3. Ruskin Company: www.ruskin.com/#sle.
- B Fabricate in accordance with SMACNA (DCS) and as indicated.
- C Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick-fastening locking devices. For insulated ducts, install minimum 1-inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.

3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.

D Access doors with sheet metal screw fasteners are not acceptable.

2.06 DUCT TEST HOLES

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

2.07 FIRE DAMPERS

- A Manufacturers:
 1. Greenheck
 2. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 3. Nailor Industries, Inc: www.nailor.com/#sle.
 4. Pottorff: www.pottorff.com/#sle.
 5. Ruskin Company: www.ruskin.com/#sle.
 6. United Enertech: www.unitedenertech.com/#sle.
- B Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C Ceiling (Radiation) Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame and 16-gauge, 0.0598-inch flap, two layers of 0.125-inch thick ceramic fiber on top side and one layer on bottom side for round flaps, with locking clip.
 1. Boot Fitting: Factory-provided el type (90 degree). Include field-provided collar.
 2. Box Fitting: Factory-provided 26 gauge, 0.0179 inch with field-provided collar.
 3. Rated for three hour service in compliance with UL 555C.
- D Horizontal Dampers: Galvanized steel, 22-gauge, 0.0299-inch frame, stainless steel closure spring, and lightweight, heat-retardant, non-asbestos fabric blanket.
- E Curtain Type Dampers: Galvanized steel with interlocking blades. Provide stainless steel closure springs and latches for horizontal installations. Configure with blades out of air stream except for 1-inch pressure-class ducts up to 12 inches in height.
- F Multiple Blade Dampers: 16-gauge, 0.0598-inch galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 by 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock.
- G Fusible Links: UL 33, separate at 165 degrees F with adjustable link straps for combination fire/balancing dampers.

2.08 FLEXIBLE DUCT CONNECTORS

- A Manufacturers:
 1. Carlisle HVAC Products; Dynair Connector Plus G90 Steel Offset Seam Neoprene Fabric: www.carlislehvac.com/#sle.
 2. Ductmate Industries, Inc, a DMI Company: www.ductmate.com/#sle.
 3. Elgen Manufacturing Company, Inc: www.elgenmfg.com/#sle.
- B Fabricate in accordance with SMACNA (DCS) and as indicated.

- C Flexible Duct Connections: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz/sq yd.
 - a. Net Fabric Width: Approximately 2 inches wide.

- D Maximum Installed Length: 14 inch.

2.09 VOLUME CONTROL DAMPERS

- A Manufacturers:
 - 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 - 2. Nailor Industries, Inc: www.nailor.com/#sle.
 - 3. Pottorff: www.pottorff.com/#sle.
 - 4. Ruskin Company: www.ruskin.com/#sle.
 - 5. United Enertech: www.unitedenertech.com/#sle.
- B Fabricate in accordance with SMACNA (DCS) and as indicated.
- C Splitter Dampers:
 - 1. Material: Same gauge as duct to 24 inches size in either direction, and two gauges heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- D Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch.
 - 2. Blade: 24 gauge, 0.0239 inch, minimum.
- E End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

2.10 LOW LEAKAGE (CLASS 1A) CONTROL DAMPERS

- A Manufacturers:
 - 1. Ruskin Company; CD50: www.ruskin.com/#sle.
 - 2. United Enertech: www.unitedenertech.com/#sle.
 - 3. Greenheck
- B Maximum Leakage Allowed: 3 cfm/sq ft at 1 in-wc.
- C Frame:
 - 1. Material: 20-gauge galvanized steel.
 - 2. Free-area: Single cross section.
 - 3. Blanked-off: Split frame into two free-area sections to allow a smaller free-area to be used for a minimum airflow intake or exhaust application and secondary free-area fully blanked-off.
- D Blade:
 - 1. Type: Single-blade rectangle shape.

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- 2. Operation: Opposed type.
- 3. Maximum Individual Blade Height: 8 inches.
- 4. Material: 12-gauge galvanized steel.
- 5. Authority: Opposed type, 5 to 50 percent (typically 10 percent).
- E Insulation: Water-resistant sound absorbing material.
- F Temperature Service Range: Minus 25 to 185 degrees F.
- G Other Requirements:
 - 1. Paint Finish: Standard.
 - 2. Sleeve or Flange: Factory-mounted standard.
 - 3. Duct Transition Fitting. As needed
 - 4. Custom: Include bird screen and insect screen.

2.11 MISCELLANEOUS PRODUCTS

- A Flexible Duct Elbow Support
 - 1. Manufacturer
 - a. FlexRight
 - 2. Clasified UL2043
 - 3. Size: 4" to 16" diameter
 - 4. Suppor Radius >8"
 - 5. ASHRAE Compliant
 - 6. Material: Recycled Polypropylene

PART 3 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 3100 for duct construction and pressure class.
- B Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C Provide duct test holes where indicated and required for testing and balancing purposes.
- D Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire-rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F Demonstrate re-setting of fire dampers to Owner's representative.
- G Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum two duct widths from duct take-off.
- H Use splitter dampers only where indicated.

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- I Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

END OF SECTION 23 3300

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**SECTION 23 3413
AXIAL HVAC FANS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Propeller fans.

1.02 RELATED REQUIREMENTS

- A Section 23 3300 - Air Duct Accessories: Backdraft dampers - metal.

1.03 REFERENCE STANDARDS

- A 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on axial fans and accessories, including fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C Manufacturer's Instructions: Indicate installation instructions.
- D Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALITY ASSURANCE

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

1.06 FIELD CONDITIONS

- A Do not use permanent fans for ventilation during construction.

PART 2 PRODUCTS

2.01 PROPELLER FANS

- A Manufacturers:
 - 1. ACME Engineering and Manufacturing Corporation: www.acmefan.com/#sle.
 - 2. Greenheck
 - 3. Loren Cook Company: www.lorencook.com/#sle.
- B Impeller: Shaped steel or steel-reinforced aluminum blade with heavy hubs, statically and dynamically balanced, keyed and locked to shaft, directly connected to motor.
- C Frame: One-piece, square steel with die-formed venturi orifice, mounting flanges, and supports, with baked enamel finish.
- D Accessories:
 - 1. Insulated Motorized Backdraft Damper: Multiple blades with offset hinge pin, blades linked; see Section 23 3300.
 - 2. Safety Screens: Expanded galvanized metal over inlet, motor, drive; to comply with 29 CFR 1910.
 - 3. Hood: Weathershield, to exclude rain and snow.
 - 4. Variable speed
- E Performance Ratings: As indicated on drawings.

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PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Provide safety screen where inlet or outlet is exposed.

END OF SECTION 23 3413

**SECTION 23 3416
CENTRIFUGAL HVAC FANS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Backward inclined centrifugal fans.
- B Bearings and drives.
- C Accessories.

1.02 RELATED REQUIREMENTS

- A Section 23 0548 - Vibration and Seismic Controls for HVAC.
- B Section 23 3300 - Air Duct Accessories: Backdraft dampers.
- C Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
- B AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- C AMCA 99 - Standards Handbook; 2025.
- D AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
- E AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- F AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
- G SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on centrifugal fans and accessories including fan curves with specified operating point plotted, power, rpm, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- C Shop Drawings: Indicate assembly of centrifugal fans and accessories including fan curves with specified operating point plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- D Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- E Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Extra Fan Belts: One set for each individual fan.

1.05 DELIVERY, STORAGE, AND HANDLING

- A Protect motors, shafts, and bearings from weather and construction dust.

1.06 FIELD CONDITIONS

- A Permanent fans may not be used for ventilation during construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Carnes, a division of Carnes Company Inc; VIBK: www.carnes.com/#sle.
- B Loren Cook Company: www.lorencook.com/#sle.
- C Greenheck

2.02 PERFORMANCE REQUIREMENTS

- A Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- B Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C Performance Base: Sea level conditions.
- D Temperature Limit: Maximum 300 degrees F.

2.03 WHEEL AND INLET

- A Backward Inclined: Aluminum construction with smooth curved inlet flange, heavy back plate, backwardly curved blades welded or riveted to flange and backplate; cast iron hub riveted to back plate and keyed to shaft with set screws.

2.04 HOUSING

- A Heavy gauge Aluminim, spot welded for AMCA 99 Class I and II fans, and continuously welded for Class III, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut.

2.05 BEARINGS AND DRIVES

- A Bearings: Heavy duty pillow block type, selfgreasing ball bearings, with ABMA STD 9 life at 50,000 hours.
- B Shafts: Hot rolled stainless steel, ground and polished, with keyway, protectively coated with lubricating oil, and shaft guard.
- C Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.06 ACCESSORIES

- A Access Doors: Shaped to fit scroll, with quick opening latches and gaskets.
- B Scroll Drain: 1/2 inch steel pipe coupling welded to low point of fan scroll.

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Install fans with resilient mountings and flexible electrical leads, see Sections 23 0548 and 26 0583.
- C Install flexible connections between fan inlet and discharge ductwork; see Section 23 3300. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.

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- D Install fan restraining snubbers; see Section 23 0548. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- E Provide fixed sheaves required for final air balance.

3.02 SCHEDULES - SEE DRAWING SCHEDULE

END OF SECTION 23 3416

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**SECTION 23 3423
HVAC POWER VENTILATORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Ceiling exhaust fans.
- B Inline centrifugal fans and blowers.

1.02 RELATED REQUIREMENTS

- A Section 23 0548 - Vibration and Seismic Controls for HVAC.
- B Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS

- A AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B AMCA 99 - Standards Handbook; 2025.
- C AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
- D AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
- E AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- F AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordination: Coordinate fan roof curbs and service utilities installation according to fan size.
- B Sequencing: Ensure that utility connections are completed in an orderly and expeditious manner.

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C Manufacturer's Instructions: Indicate installation instructions.
- D Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.06 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 MANUFACTURERS - APPROVED FOR ALL CATAGORIES

- A Carnes, a division of Carnes Company Inc: www.carnes.com/#sle.
- B Greenheck Fan Corporation: www.greenheck.com/#sle.
- C Loren Cook Company: www.lorencook.com/#sle.
- D Twin City Fan & Blower: www.tcf.com/#sle.

2.02 POWER VENTILATORS - GENERAL

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

2.03 CEILING EXHAUST FANS

- A Manufacturers:
 - 1. Broan-NuTone, LLC; 744 Recessed Ventilation Fan with Light: www.broan-nutone.com/#sle.
 - 2. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 3. Panasonic Corporation of North America; WhisperRecessed LED: www.panasonic.com/#sle.
- B Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resiliently mounted motor, gravity backdraft damper in discharge.
- C Disconnect Switch: Cord and plug-in housing for thermal overload protected motor and control noted on drawing schedule..
- D Grille: Molded white plastic.
- E Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is reached with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- F Accessories
 - 1. Radiation Damper installed in fan assembly.
- G Performance Ratings: As indicated on drawings.

2.04 INLINE CENTRIFUGAL FANS AND BLOWERS

- A Centrifugal Fan Unit: V-belt or direct driven, with galvanized steel housing lined with acoustic insulation, resiliently-mounted motor, gravity backdraft damper in discharge.
- B Backward Inclined Blower:
 - 1. Direct-driven, resiliently mounted motor, heavy-duty ball bearings, powder-coated steel housing for outdoor service, and removable service panels.
 - 2. Operation: As indicated on drawings.
 - 3. Accessories: Provide external vibration isolator spring and filter section.
- C Disconnect Switch: Cord and plug-in housing for thermal overload protected motor and wall mounted switch.
- D Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm gets reached with sheaves set at mid-position; fan shaft with self-aligning prelubricated ball bearings.

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PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.
- B Hung Cabinet Fans:
 - 1. Install fans with resilient mountings and flexible electrical leads, see Section 23 0548.
 - 2. Install flexible connections between fan and ductwork; see Section 23 3300. Ensure metal bands of connectors are parallel with minimum 1 inch flex between ductwork and fan while running.
- C Install backdraft dampers on inlet to roof and wall exhausters.
- D Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.

3.02 SCHEDULES - SEE DRAWING SCHEDULES

END OF SECTION 23 3423

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**SECTION 23 3440
AIR DESTRATIFICATION FANS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Destratification fans for thermal equalization of buildings.

1.02 RELATED SECTIONS

- A Section 26 00 00, "Common Work Results for Electrical".

1.03 REFERENCES

- A UL 507: Underwriters Laboratory Standard for Electric Fans
- B CAN//CSA-C22.2 No. 1113: Safety of household and similar electrical appliances.
- C CE: Product is certified to meet EU consumer safety, health or environmental requirements.
- D UL 94 5VA: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- E ISO3744 Engineering Grade Acoustical Testing
- F NEC: National Electric Code.
- G ETL: Listed for US and Canada in Intertek Directory of Listed Products.

1.04 SUBMITTALS

- A Submit under provisions of Section 01 33 00, "Administrative Requirements".
- B Product Data: Manufacturer's data sheets for each product, including:
 - 1. Power requirements and mounting recommendations.
 - 2. Fan velocity profile showing isothermal feet per minute (FPM) delivery at various distances from fan.
- C Shop Drawings:
 - 1. Placement Drawings: Include manufacturer's placement recommendation diagram.
 - 2. Wiring Diagrams.
 - 3. Mounting details, including safety restraint where required.
- D Revit Files
- E Manufacturer's Instructions: Provide manufacturer's "Installation, Operation, and Maintenance Manual"
- F Schedule

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Minimum of fifteen (19) years of product experience. Providing sole source for fans, accessories, and controls.

1.06 DELIVERY, STORAGE, AND HANDLING

- A Deliver products and materials to project site in manufacturer's unopened packaging.
- B Store products in manufacturer's unopened packaging until ready for installation.

1.07 PROJECT CONDITIONS

- A Maintain temperature, humidity, and ventilation within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

- A Warranty: Refer to warranty information contained in the “Installation, Operation & Maintenance Manual”.
- B Factory Refurbish Program: Users can purchase a motor replacement or a new discounted system upon failure outside the warranty period. Contact manufacturer for details.

1.09 REFERENCE STANDARDS

- A UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances; Current Edition, Including All Revisions.
- B UL 507 - Electric Fans; Current Edition, Including All Revisions.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A Airius, LLC, which is located at: 811 S. Sherman St., Longmont, CO 80501 Toll Free Tel: 888-247-7327; Tel: 303-772-2633; Email: info@airiusfans.com; Web: www.airiusfans.com
- B Zoo Fans

2.02 AIRIUS AIR PEAR DESTRATIFICATION FANS

- A Performance: Coordinated design of housing, stator and motor shall provide columnar laminar airflow to produce a minimum of 100 fpm at center of column at grade level when installed within 2'-0" of ceiling. Refer to manufacturer's airflow velocity profiles for jet pattern and throw data.
- B Housing: The fan housing shall be made of PC/ABS resin, rated 5VA for flame resistance.
 - 1. Housing color:
 - a. PMS Cool Gray 2C (off white)
 - b. Black
 - c. As scheduled
- C Safety Cable: Supplied with 6'-0" steel cable fastened to seismic restraint point integrated into the fan housing. Safety restraint attached to primary mounting handle will not be accepted.
- D Motor Mounting: Enclosed in housing, above stator.
- E Stator: The fan shall be equipped with a patented curved multiple-vane stator coordinated with fan design for maximizing columnar laminar flow.
- F Certification: UL Standard 507 for Safety Electric Fans, CAN//CSA-C22.2 No. 1113 and UL 94 5VA as certified by nationally recognized testing laboratory. Acceptable laboratories include ETL, UL or other nationally recognized testing laboratories.
- G Identification: Permanently affixed manufacturer's nameplate including the following: Model Number, Serial Number, Motor Power Specifications, Country of Manufacture and Safety Marks: ETL (US & CA) & CE (EU).
- H Power Cord: 6 foot, 300-volt AC, UL rated. Motors within the voltage range of 100-130VAC are provided with a standard 3-prong plug. Motors within the voltage range of 200-277VAC are not provided with a plug.
- I Destratification Fan shall be an Air Pear Model 60.
 - 1. Size and Weight: Standard 32 inch height to bail; 24 inch height to rim. 20 inch diameter, 22lb (10kg)

2. Motor (P4): Permanent split capacitor, 4-pole motor, 330mm in diameter. Steel blades welded to steel hub. Ball bearings shall be permanently lubricated and shielded. Up to 1333 cfm, 1489 rpm, 75.2 dBA. Thermally protected motor with an operating range of -13° F (-25° C) to 167° F (75° C).
 - a. Recommended ceiling height up to 60 feet (18.3 m) and area coverage up to 2000 sq. ft. (186 sq. m); 25 feet (7.6 m) from the fan's center in all directions.
 - b. Electrical Requirements:
 - 1) 120V AC, single phase, 60 Hz.; 1.35 Amps; 162 watts
 - 2) 277V AC, single phase, 60 Hz.; 0.68 Amps; 170 watts
 - c. Controls shall be coordinated with motor electrical requirements.
 - 1) Provide with an inline, wall mounted, TRIAC controller for variable speed and on/off.
 - 2) Provide with Airius 10A transformer for BAS integration. Installed on fan power circuit, accepts 0-10VDC signal to adjust fan speed over 8 steps.
 - 3) Provide with an Airius Delta T Controller with automatic temperature-based control. Utilizes two manufacturer supplied temperature sensors for mounting at ceiling and floor to vary fan speed based on temperature delta.
 - 4) None
3. Motor (EC): Electronically commutated motor, up to 92% efficient, 330mm in diameter. Steel blades welded to steel hub. Ball bearings shall be permanently lubricated and shielded. Up to 1342 cfm, 1605 rpm, 78.2 dBA. Thermally protected motor with an operating range of -13° F (-25° C) to 140° F (60° C).
 - a. Recommended ceiling height up to 60 feet (18.3 m) and area coverage up to 2000 sq. ft. (186 sq. m); 25 feet (7.6 m) from the fan's center in all directions.
 - b. Electrical Requirements:
 - 1) 100-130V AC, single phase, 60 Hz.; 1.8 Amps; 143 watts
 - 2) 200-277V AC, single phase, 60 Hz.; 1.3 Amps; 170 watts.
 - c. Controls shall be coordinated with motor selection.
 - 1) Shall be controlled directly by 0-10VDC control signal from BAS. Uses low voltage control circuit separate from mains power. See wiring diagram.
 - 2) Provide with wall mounted potentiometer. Uses low voltage control circuit for single or multiple fan control. See wiring diagram.
 - 3) Provide with PearLink WiFi control. Requires 2.4GHz WiFi network for communication with PearLink mobile application. Mobile application (iOS and Android) to include scheduling, temperature/humidity based automation capability, fan status monitoring and error alerts. See cut sheet for further details.
 - 4) Provide with an Airius Delta T Controller with automatic temperature-based control. Utilizes two manufacturer supplied temperature sensors for mounting at ceiling and floor to vary fan speed based on temperature delta.

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- 5) Provide with BACnet MS/TP card for individual fan control and status integration with BAS.
- 6) None

PART 3 EXECUTION

3.01 EXAMINATION

- A Do not begin installation until supporting structure and interior work have been properly completed.
- B Check location and availability of utility services to ensure proper voltage and installation preparation.
- C Installation of miscellaneous support, if required, electrical wire and wiring, conduit, fuses, and disconnect switches other than those provided by fan manufacturer are specified in other sections.
- D Examine the substrate and conditions under which the Fan is to be installed. Notify the Architect in writing of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A Install destratification fan according to manufacturer's written recommendations.
- B Fan to be mounted at a maximum of 2'-0" from ceiling deck to ensure thermal/humidity equalization from ceiling to floor.
- C Adjust unit as required for proper operation in accordance with manufacturer's installation instructions.

3.03 PROTECTION

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

END OF SECTION 23 3440

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Diffusers:
- B Rectangular ceiling diffusers.
- C Round ceiling diffusers.
- D Registers/grilles:
 - 1. Ceiling-mounted, exhaust and return register/grilles.
 - 2. Ceiling-mounted, supply register/grilles.
 - 3. Wall-mounted, supply register/grilles.
 - 4. Wall-mounted, exhaust and return register/grilles.
- E Duct-mounted supply and return registers/louvers.
- F Louvers:
- G Goosenecks.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2012, with Editorial Revision (2015).
- B ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets; 2023.
- C SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

1.05 QUALITY ASSURANCE

- A Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- B Test and rate louver performance in accordance with AMCA 500-L.
- C Provide room schedule and coordinate with general items located in the ceiling and floor. Ceiling items include but are not limited to lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and moldings.
- D Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Metalaire, a brand of Metal Industries Inc: www.metalaire.com/#sle.
- B Price Industries: www.price-hvac.com/#sle.
- C Ruskin Company: www.ruskin.com/#sle.
- D Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/#sle.

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- E Tuttle and Bailey: www.tuttleandbailey.com/#sle.
- F Nailor.

2.02 ROUND CEILING DIFFUSERS

- A Type: Round, stamped or spun, multicore diffuser to discharge air in 360-degree pattern, with sectorizing baffles where indicated. Project diffuser collar not more than 1 inch above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
- B Fabrication: Steel with baked enamel finish.
- C Color: As indicated on drawings.
- D Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 RECTANGULAR CEILING DIFFUSERS

- A Type: Provide rectangular and square formed Plaque ceiling diffusers constructed to maintain 360 degree discharge air pattern.
- B Connections: Round.
- C Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
- D Fabrication: Steel with baked enamel finish.
- E Color: As indicated.
- F Accessories: Provide radial opposed blade and butterfly volume control damper; plaster ring and gaskets for surface mounted diffusers with damper adjustable from diffuser face.

2.04 DUCT-MOUNTED SUPPLY AND RETURN REGISTERS/LOUVERS

- A Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.
- B Material: 22 gauge, 0.0299 inch.
 - 1. Provide crossing spiral fitting-body of matching duct diameter.
- C Color: As indicated on drawings.

2.05 CEILING SUPPLY REGISTERS/GRILLES

- A Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, two-way deflection.
- B Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C Construction: Made of aluminum extrusions with factory enamel finish.
- D Color: As indicated.
- E Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- F Solid Ceiling Accessory: Provide plaster ring for all diffusers in solid surface ceiling with gaskets.

2.06 CEILING EXHAUST AND RETURN REGISTERS/GRILLES

- A Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with blades set at 45 degrees, vertical face.

- B Frame: 1-1/4 inch margin with countersunk screw mounting.
- C Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D Color: As indicated.
- E Solid Ceiling Accessory: Provide plaster ring for all diffusers in solid surface ceiling with gaskets.

2.07 WALL SUPPLY REGISTERS/GRILLES

- A Type: Streamlined and individually adjustable blades, 3/4 inch minimum depth, 3/4 inch maximum spacing with spring or other device to set blades, vertical face, double deflection.
- B Frame: 1-1/4 inch margin with countersunk screw mounting and gasket.
- C Fabrication: Steel with 20 gauge, 0.0359 inch minimum frames and 22 gauge, 0.0299 inch minimum blades, steel and aluminum with 20 gauge, 0.0359 inch minimum frame, or aluminum extrusions, with factory baked enamel finish.
- D Color: As indicated.
- E Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.08 WALL EXHAUST AND RETURN REGISTERS/GRILLES

- A Type: Streamlined blades, 3/4 inch minimum depth, 3/4 inch maximum spacing, with spring or other device to set blades, vertical face.
- B Frame: 1-1/4 inch margin with countersunk screw mounting.
- C Fabrication: Steel frames and blades, with factory baked enamel finish.
- D Color: As indicated on the drawings.
- E Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.

2.09 LOUVERS

- A Manufacturers:
 - 1. Ruskin Company: www.ruskin.com/#sle.
 - 2. Greenheck
 - 3. Pottorff
- B Type: 6 inch or 4 inch (as scheduled) deep frame with blades on 45 degree slope with center baffle and return bend, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.
- C Fabrication: 12 gauge, 0.1046 inch (2.66 mm) thick extruded aluminum thick galvanized steel welded assembly, with factory fluoropolymer spray finish.
- D Finish: 70% Kynar Finish or 100% Fluor
- E Color: As indicated on the drawings.
- F Mounting: Furnish with interior flat flange for installation.

2.10 GOOSENECKS

- A Fabricate in accordance with of minimum 18 gauge, 0.0598 inch galvanized steel.

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- B Mount on minimum 12 inch high curb base where size exceeds 9 by 9 inch.

PART 3 EXECUTION

3.01 INSTALLATION

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

3.02 CLOSEOUT ACTIVITIES

- A Demonstrate operational system to Owner's representative.
- B Instruct Owner's representative to maintain system and use occupant controls or interfaces, as required.

3.03 PROTECTION

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

END OF SECTION 23 3700

**SECTION 23 5216
CONDENSING BOILERS**

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 SECTION INCLUDES

- A Gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

1.03 SUBMITTALS

- A Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B Shop Drawings: For boilers, boiler trim, and accessories.
 - 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. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A Seismic Qualification Certificates: For boiler, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B Source quality-control reports.
- C Field quality-control reports.
- D Sample Warranty: For special warranty.
- E Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
 - 2. CSA B51 pressure vessel Canadian Registration Number (CRN).

1.05 CLOSEOUT SUBMITTALS

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

1.06 WARRANTY

- A Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Leakage and Materials: 10 years from date of Substantial Completion.
 - b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for 5 years from date of Substantial Completion.

PART 2 PRODUCTS

2.01 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 ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- C ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.
- E UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F CSA Compliance: Test boilers for compliance with CSA B51.
- G Mounting Base: For securing boiler to existing concrete base.

2.02 WATER-TUBE CONDENSING BOILERS

- A Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. AERCO
 - 2. Thermal Solutions – Apex and Artic
 - 3. Lochinvar
- B Description: Factory-fabricated, -assembled, and -tested, copper-finned, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.
- C Heat Exchanger: Finned-copper primary and stainless-steel secondary heat exchangers.
- D Combustion Chamber: Stainless steel, sealed.
- E Burner: Natural gas, forced draft drawing from gas premixing valve.
- F Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G Gas Train: Combination gas valve with manual shutoff and pressure regulator.

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H Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.

I Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Textured epoxy.
4. Insulation: Minimum 1-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

J Capacities and Characteristics: See Drawings

2.03 TRIM

A Minnesota and North Dakota Compliant Trim

B Include devices sized to comply with ASME B31.1.

C Pressure Controllers: Operating, firing rate, and high limit.

D Safety Relief Valve:

1. Size and Capacity: As required for equipment according to 2010 ASME Boiler and Pressure Vessel Code.
2. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
 - a. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

E Pressure Gage: Minimum 3-1/2-inch diameter. Gage shall have normal operating pressure about 50 percent of full range.

2.04 CONTROLS

A Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 140; at 60 deg F outside-air temperature, set supply-water temperature at 120.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

B Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.

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2. Low-Water Cutoff Switch: Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
1. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.
 2. Interface shall be provided by Boiler Manufacturer for staging and sequencing all high efficiency boilers along with programming to allow for control of fuel oil / natural gas boiler on a call for heat or natural gas interruption.
 3. Interface shall be BacNet and verified with controls contractor.

2.05 ELECTRICAL POWER

- A Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
1. House in NEMA 250, Type 1 enclosure.
 2. Wiring shall be numbered and color coded to match wiring diagram.
 3. Install factory wiring outside of an enclosure in a metal raceway.
 4. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 5. Provide each motor with overcurrent protection.

2.06 VENTING KITS

- A Combustion-Air Intake: Complete system, CPVC pipe, vent terminal with screen, inlet air coupling, and sealant.
- B Polypropylene Piping, AL29. PVC Not allowed.
- C Boilers shall be individually vented for both combustion and outside air. No concentric venting is allowed.

2.07 SOURCE QUALITY CONTROL

- A Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B Test and inspect factory-assembled boilers, before shipping, according to 2010 ASME Boiler and Pressure Vessel Code.

- C Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B Examine mechanical spaces for suitable conditions where boilers will be installed.
- C Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 BOILER INSTALLATION

- A Equipment Mounting:
 - 1. Install boilers on cast-in-place concrete equipment base(s).
- B Install gas-fired boilers according to NFPA 54.
- C Assemble and install boiler trim.
- D Install electrical devices furnished with boiler but not specified to be factory mounted.
- E Install control wiring to field-mounted electrical devices.

3.03 CONNECTIONS

- A Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B Install piping adjacent to boiler to allow service and maintenance.
- C Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 23 21 16 "Hydronic Piping Specialties."
- E Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required. Regulator for boiler shall be at least 10 feet away from boiler and installed as per manufacturers recommendations.
- F Connect hot-water piping to supply- and return-boiler tapings with shutoff valve and union or flange at each connection.
- G Install piping from safety relief valves to nearest floor drain.
- H Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- I Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.

3.04 FIELD QUALITY CONTROL

- A Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B Perform the following tests and inspections:

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1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

BOILER WILL BE CONSIDERED DEFECTIVE IF IT DOES NOT PASS TESTS AND INSPECTIONS.

- A Prepare test and inspection reports.
- B Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

4.02 PERFORMANCE TESTING

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine capacity and efficiency of boilers.
 - a. Test for full capacity.
 - b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.
4. Repeat tests until results comply with requirements indicated.
5. Provide analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify COTR 24 hours minimum in advance of test dates.
8. Document test results in a report and submit to Architect.

END OF SECTION 23 5216

**SECTION 23 5400
FURNACES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Forced air furnaces.
- B Refrigeration Components
- C Thermostats.
- D Equipment Drains and Overflows
- E Equipment Drain Insulation
- F Equipment Mounting

1.02 REFERENCE STANDARDS

- A ANSI Z21.47 - American National Standard for Gas-Fired Central Furnaces; 2021.
- B ASHRAE Std 103 - Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers; 2022.
- C ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- E ASTM B32 - Standard Specification for Solder Metal; 2020.
- F ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- G ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- H ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.
- I ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- J ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2025a.
- K ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.
- L 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).
- M NFPA 54 - National Fuel Gas Code; 2024.
- N NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- O NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2024.

1.03 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

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- D Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- E Project Record Documents: Record actual locations of components and connections.

1.04 QUALITY ASSURANCE

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

1.05 WARRANTY

- A See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B Provide ten year manufacturers warranty for heat exchangers.
- C Provide 5 years on integrated circuit boards and integrated ignition parts
- D Provide 5 years on draft inducer motor

PART 2 PRODUCTS

2.01 GAS FIRED FURNACES

- A Manufacturers:
 - 1. Constant Volume Systems
 - a. Carrier
 - b. Daikin
 - c. Rheem Manufacturing Company Inc: www.rheem.com/#sle.
 - d. York International Corporation / Johnson Controls: www.york.com/#sle.
- B Annual Fuel Utilization Efficiency (AFUE): 0.95 ("condensing") in accordance with ASHRAE Std 103.
- C Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating element, controls, air filter, humidifier, and accessories; wired for single power connection with control transformer.
 - 1. Safety certified by CSA in accordance with ANSI Z21.47.
 - 2. Venting System: Direct.
 - 3. Combustion: Sealed.
 - 4. Air Flow Configuration: Downflow.
 - 5. Heating: Natural gas fired.
 - 6. Intake and Vent Materials
 - a. Polypropylene Vent UL-1738 Centrotherm or equal
 - b. PVC System by Ipex UL 1738 along with all rated fittings
 - c. Standard PVC not approved
 - 7. Accessories:
 - a. Condensate drain.
 - b. Roof termination kit
 - c. Wall termination kit.
 - d. Provide Manufactured 4" Filter Rack 20x25x4 or
 - e. Provide furnace return support plenum with Filter 20x25x4
 - 8. Performance:

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- a. Refer to Furnace Schedule. Gas heating capacities are sea level ratings.
9. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner. Provide pad for furnace as needed to set on combustible floor if applicable.
10. Primary Heat Exchanger:
 - a. Material: Hot-rolled steel.
 - b. Shape: Tubular type.
11. Secondary Heat Exchanger:
 - a. Material: Stainless steel.
 - b. Shape: Serpentine, clamshell, or tubular.
12. Gas Burner:
 - a. Atmospheric type with adjustable combustion air supply.
 - b. Gas valve, variable capacity provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 - c. Electronic pilot ignition, with electric spark igniter.
 - d. Non-corrosive ECM combustion air blower with permanently lubricated motor.
13. Gas Burner Safety Controls:
 - a. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 - b. Flame rollout switch: Installed on burner box and prevents operation.
 - c. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
 - d. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic resets.
14. Supply Fan: Centrifugal type rubber mounted with direct drive.
15. Motor: ECM Motor controlled by integrated furnace blower controller.
16. Air Filters: 4" thick glass fiber, disposable type arranged for easy replacement.
17. Operating Controls:
 - a. Room Thermostat: Cycles burner to maintain room temperature setting.
 - b. Supply Fan Control: Energize from bonnet temperature independent of burner controls, with adjustable timed off delay and fixed timed on delay, with manual switch for continuous fan operation. Provide continuous low speed fan operation.
18. Refrigerant Detection
 - a. Furnaces with R-32 or R454B shall have on board refrigerant detections systems which comply with authority having jurisdiction.

2.02 REFRIGERATION COMPONENTS

A General Refrigeration Component Requirements:

1. Refrigeration compressor, coils, and specialties shall be designed to operate with CFC-free refrigerants.

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2. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
- B Refrigerant Coil: Copper tubes mechanically expanded into aluminum fins. Comply with ARI 210/240, "Unitary Air-Conditioning and Air-Source Heat Pump Equipment." Match size with furnace. Include condensate drain pan with accessible drain outlet complying with ASHRAE 62.1.
 1. Refrigerant Coil Enclosure: Steel, matching furnace and evaporator coil, with access panel and flanges for integral mounting at or on furnace cabinet and galvanized sheet metal drain pan coated with black asphaltic base paint.
- C Refrigerant Line Kits: Annealed-copper suction and liquid lines factory cleaned, dried, pressurized with nitrogen, sealed, and with suction line insulated. Provide in standard lengths for installation without joints, except at equipment connections.
 1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I, 1/2 inch thick.
- D Air-Cooled, Compressor-Condenser Unit:
 1. Casing: Steel, finished with baked enamel, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
 2. Compressor: Hermetically sealed scroll type.
 3. Crankcase heater.
 4. Vibration isolation mounts for compressor.
 5. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 6. Multi-speed compressor motors shall have manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - a. Minimum two stage compressor or variable speed.
- E Refrigerant Charge: Puron, R32, or R-454B
- F Refrigerant:
 1. R-32 with onboard detection
 2. R-454B with onboard detection
- G Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- H Heat-Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- I Fan: Aluminum-propeller type, directly connected to motor.
- J Motor: Permanently lubricated, with integral thermal-overload protection.
- K Low Ambient Kit: Permits operation down to 10 deg F.
- L Mounting Base: Polyethylene.
- M Capacities and Characteristics: See drawing schedule.
- N Compressor-Condenser Unit:
 1. Cooling Energy Efficiency (SEER): 15.5.
 2. Volts: 208-240.

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3. Phase: 1.
4. Hertz: 60.

2.03 THERMOSTATS

- A Manufacturers:
 1. Carrier Corporation for zone controlled systems and single zone systems.
 2. Honeywell Thermostates with wireless access for single zone systems.
- B Room Thermostat: Low voltage, electric solid state microcomputer based room thermostat with remote sensor:
 1. Honeywell Pro 9000 Smarth Color Touchscreen Thermostat
 2. System selector switch (heat-off) and fan control switch (auto-on).
 3. Preferential rate control to minimize overshoot and deviation from setpoint.
 4. Set-up for four separate temperatures per day.
 5. Instant override of setpoint for continuous or timed period from one hour to 31 days.
 6. Programming based on weekdays, Saturday and Sunday.
 7. Selection features including degree F or degree C display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
 8. WiFi Capable
 9. Battery replacement without program loss.
 10. Thermostat Display:
 - a. Actual room temperature.
 - b. Programmed temperature.
 - c. System Mode Indication: Heating, cooling, fan auto, off, and on, auto or on, off.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

- A Copper Tube: ASTM B88 (ASTM B88M), Type M (C), drawn; using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- B PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
 1. Fittings: ASTM D2466 or D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.

2.05 EQUIPMENT DRAIN INSULATION

- A Flexible Elastomeric Insulation
 1. Manufacturers:
 - a. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 - b. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 - c. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
 2. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 3. Minimum Service Temperature: Minus 40 degrees F.
 4. Maximum Service Temperature: 180 degrees F.

- 5. Connection: Waterproof vapor barrier adhesive.
- 6. Plenum Rated
- B Provide 3/8" insulation on all equipment drains and overflows above ceilings and routed in concealed shafts and spaces.

2.06 EQUIPMENT MOUNTING (WALL AND ROOF)

- A Manufacturers
 - 1. DiversiTech
 - 2. Approved Equal
- B Roof Mounted Units
 - 1. Materials of Construction
 - a. Powder Coated Steel
 - b. Hurrican/Seismic Code Compliant
 - c. Applications
 - 1) Single Fan Units
 - 2) Dual Fan Units
 - 3) Multi Unit Capability
 - 2. Provide complete manufactured assembly for roof or wall mouting of condensing units.
 - a. Minimum Height off Roof: 12"
 - b. Minimum Foot Size: 12x12 with Vibration/Protection pad between foot and roof membrane.
 - c. Vibration Isolation: High Density elastomeric-coated pre compressed fiberglass strips which are UV resistant.
 - 3. Provide complete manufactured assembly for roof or wall mouting of condensing units.
 - a. Minimum Height off Roof: 12"
 - b. Minimum Foot Size: 12x12 with Vibration/Protection pad between foot and roof membrane.
 - c. Vibration Isolation: High Density elastomeric-coated pre compressed fiberglass strips which are UV resistant.
 - d. Provide Pitched Roof Bracket when necessary for 9-45 degrees.
 - e. High Wind Resistant to 100 M
- C Wall Mounted Units
 - 1. Materials of Construction
 - a. Aluminum Construction for al Units up to 150 lbs
 - b. Powder Coated or Galvanized Steel for all units over 150 lbs.
 - c. Hurrican/Seismic Code Compliant
 - d. Applications
 - 1) Single Fan Units
 - 2) Dual Fan Units

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PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions and requirements of authorities having jurisdiction.
- B Install in accordance with NFPA 90A.
- C Install gas fired furnaces in accordance with NFPA 54.
- D Install ground-mounted, compressor-condenser components on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit. Place unit on premanufactured heat pump stand.
- E Provide vent connections in accordance with NFPA 211.
- F Mount counterflow furnaces installed on combustible floors on additive base.
- G Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
- H Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.
 - 1. Anchor furnace to substrate to resist code-required seismic acceleration.
- I Vent and Outside-Air Connection, Condensing, Gas-Fired Furnaces: Connect Polypropylene plastic piping vent material to furnace connections and extend outdoors. Terminate vent outdoors with a cap and in an arrangement that will protect against entry of birds, insects, and dirt.
 - 1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - 2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - 3. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 4. Slope pipe vent back to furnace or to outside terminal.
- J Complete installation and startup checks and start units according to manufacturer's written instructions.
- K Verify proper operation of capacity control device.
- L Adjust airflow and initial temperature and humidity set points.
- M Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating and cooling performance and system efficiency.
- N Connect refrigerant tubing kits to refrigerant coil in furnace and to air-cooled, compressor-condenser unit.

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1. Flared Joints: Use ASME B16.26 fitting and flared ends, following procedures in CDA's "Copper Tube Handbook."
 2. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
 3. 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.
- O After completing installation, clean furnaces internally according to manufacturer's written instructions.
- P Install new filters in each furnace within 14 days after Substantial Completion.

END OF SECTION 23 5400

**SECTION 23 5533
FUEL-FIRED UNIT HEATERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Gas fired unit heaters.
- B Tubular infrared heaters.

1.02 RELATED REQUIREMENTS

- A Section 23 5100 - Breechings, Chimneys, and Stacks.

1.03 REFERENCE STANDARDS

- A ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- B ASHRAE Std 103 - Method of Testing for Annual Fuel Utilization Efficiency of Residential Central Furnaces and Boilers; 2022.
- C NFPA 54 - National Fuel Gas Code; 2024.
- D NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- F NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances; 2024.
- G UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
- D Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 WARRANTY

- A See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B Provide five year manufacturers warranty for heat exchangers and one year parts and labor for entire unit.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A Comply with NFPA 70.
- B Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

2.02 GAS FIRED UNIT HEATERS

- A Manufacturers:

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1. Modine Manufacturing Company: www.modine.com/#sle.
 2. Sterling HVAC/Mestek Technology, Inc: www.sterlinghvac.com/#sle.
 3. Reznor/Thomas & Betts Corporation: www.reznorhvac.com/#sle.
- B Unit Heaters: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
1. Heating: Natural gas fired.
 2. Discharge Louvers: Individually adjustable horizontal and vertical louvers to match cabinet finish.
- C Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors, glass fiber insulation and reflective liner.
- D Supply Fan: Propeller type with direct drive, variable pitch motor pulley.
- E Heat Exchanger: Aluminized steel welded construction.
- F Gas Burner:
1. Atmospheric type with adjustable combustion air supply.
 2. Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 3. Electronic pilot ignition, with electric spark igniter.
 4. Field Convertable for seperated combustion
- G Gas Burner Safety Controls:
1. Thermocouple Sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
 2. Vent Safety Shutoff Sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
- H Operating Controls:
1. Room Thermostat: Cycles burner to maintain room temperature setting.
 2. Supply Fan Control: Energize from bonnet temperature independent of burner controls, with adjustable timed off delay and fixed timed on delay, with manual switch for continuous fan operation.
- I Venting Requirements
1. All Exhaust vents shall be run independantly
 2. Catagory III Venting Selkirk Saf-T-Vent or Equal
 3. Provide Rain cap or side wall cap as approved by Manufacturer
 4. Intake combustion air piping shall be single wall sealed galvanized pipe or other approve materials.
 5. Concentric venting is allowed utilized manufacture supplied conversion kits.
- J Performance:
1. Ratings: Energy Efficiency Rating (EER)/Coefficient of Performance (COP) not less than requirements of ASHRAE Std 90.1 I-P; seasonal efficiency to ASHRAE Std 103.

2.03 TUBULAR INFRARED HEATERS

- A Manufacturers:

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1. Detroit Radiant Products Company: www.reverberay.com/#sle.
 2. Space-Ray, Division of Gas Fired Products, Inc; _____: www.spaceray.com/#sle.
 3. Roberts Gorden - Co Ray Vac.
- B Infrared Heaters: Tubular type; packaged, partially factory assembled, pre-wired unit consisting of cabinet, burner, heat exchanger, radiant tube, reflector, controls; for natural gas.
- C Heat Exchanger: Stainless steel combustion chamber with black coated titanium steel tube with aluminum reflector.
- D Gas Burner:
1. Gas Burner: Induced draft type with adjustable combustion air supply.
 2. Gas valve provides 100 percent safety gas shut-off; 24 volt combining pressure regulation, safety pilot, manual set (On-Off), pilot filtration, automatic electric valve.
 3. Electronic pilot ignition, with electric spark igniter.
 4. Non-corrosive exhaust air blower with permanently lubricated motor.
- E Gas Burner Safety Controls: Thermo-couple sensor prevents opening of solenoid gas valve until pilot flame is proven and stops gas flow on ignition failure.
- F Operating Controls: Low voltage room thermostat cycles burner to maintain room temperature setting.
- G Requirements:
1. Equipped with intermittent ignition device.
 2. Equipped with power venting.
 3. Provide stainless steel vent cap.
- H Performance: See Drawing Schedule for details and configuration

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A Install in accordance with NFPA 90A.
- B Install gas fired units in accordance with NFPA 54 and applicable codes.
- C Provide vent connections in accordance with NFPA 211. Refer to Section 23 5100.

END OF SECTION 23 5533

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SECTION 23 6426
ROTARY-SCREW WATER CHILLERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Air-cooled rotary-screw chiller.

1.02 RELATED REQUIREMENTS

- A Section 03 3000 - Cast-in-Place Concrete: Concrete housekeeping pads.
- B Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- C Section 23 0800 - Commissioning of HVAC.
- D Section 23 0923 - Direct-Digital Control System for HVAC.
- E Section 23 0993 - Sequence of Operations for HVAC Controls.
- F Section 23 2113 - Hydronic Piping.
- G Section 23 2114 - Hydronic Specialties.
- H Section 25 1500 - Integrated Automation Software.
- I Section 25 3519 - Integrated Automation Control Valves.
- J Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A AHRI 550/590 (I-P) - Performance Rating of Water-Chilling and Heat Pump Water-Heating Packages Using the Vapor Compression Cycle; 2023.
- B ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).
- C ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata (2023).
- E ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023, with Errata (2024).
- F ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus; 2019.
- G IEEE 519 - IEEE Standard for Harmonic Control in Electric Power Systems; 2022.
- H NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- I NEMA MG 00001 - Motors and Generators; 2024.
- J UL 984 - Hermetic Refrigerant Motor-Compressors; Current Edition, Including All Revisions.
- K UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Engineer of any major deviations from the equipment originally specified prior to ordering equipment.

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.

- B Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- C Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- D Manufacturer's Performance Data: Indicate energy input versus cooling load output from 0 to 100 percent of full load at specified and minimum condenser water temperature for water-cooled chillers and at specified and minimum outdoor air temperature for air-cooled chillers.
- E Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.
- B Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.08 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials and labor for complete assembly.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Carrier Corporation: www.carrier.com/#sle.
- B Daikin Applied: www.daikinapplied.com/#sle.
- C Dunham Busch
- D York, a brand of Johnson Controls International, PLC; _____: www.york.com/#sle.

2.02 ROTARY-SCREW WATER CHILLER PERFORMANCE REQUIREMENTS

- A Packaged Air-Cooled Chiller:
 - 1. Refrigerant: R-454B, use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) no greater than that allowed by federal code.
 - 2. Energy Efficiency: ASHRAE Std 90.1.
 - a. Energy Efficiency Ratio: Equal or higher than 10.8 at full load and 18.11 at integrated part load value.
 - 3. Evaporator: See Drawing Schedule
 - a. Fouling Factor: 0.00010 sq ft-hr-degrees F/Btu.
 - 4. Air-Cooled Condenser: See Drawing Schedule

2.03 AIR-COOLED, ROTARY-SCREW, WATER CHILLER CONSTRUCTION REQUIREMENTS

- A Factory assembled and tested chiller consisting of compressor(s), compressor motor(s), motor starter(s) or variable frequency drives as indicated, evaporator, condenser, enclosure, refrigeration circuit(s) and specialties, interconnecting piping, microprocessor-based controls, readouts, and diagnostics.
1. Rating: AHRI 550/590 (I-P).
 2. Safety: ASHRAE Std 15 and UL 1995.
 3. Construction and Testing: ASME BPVC-VIII-1.
 4. Energy Efficiency: ASHRAE Std 90.1.
 5. Enclosures:
 - a. Structural Framing: Mount structural steel on welded steel base with hot-dip galvanized finish.
 - b. Steel Cabinet:
 - 1) Factory apply baked on powder paint or corrosion resistant paint prior to assembly.
 - 2) Provide gasketing and weatherproofing to panels with fully opening doors containing starters or variable frequency drives, terminal blocks, through-the-door type disconnects and circuit breaker with lockable handles indicating "power-on" or "power-off".
 - 3) Provide door stays.
 - c. Perform 500-hour salt spray test in accordance with ASTM B117 for outdoor applications.
- B Rotary-Screw Compressors:
1. Unit: Semi-hermetic type with two, direct drive compressors with multiple independent refrigeration circuit(s), internal muffler, discharge, check, and suction service valves.
 2. Oil Lubrication System: Positive pressure system, oil heater, oil separator, check valves, solenoid valves, and filtration devices.
 3. Valves: Check valves in compressor discharge.
 4. Capacity Reduction System: Load/unload valve control down to 20 percent of full load without the activation of hot gas bypass.
 5. Motors: UL 984, 3,600 rpm, suction gas-cooled, hermetically sealed, squirrel cage induction with starter.
- C Evaporator, Shell and Tube Type:
1. ASME BPVC-VIII-1, three pass type, with three independent refrigeration circuits.
 2. Shell, Removable Heads and Tube Support Sheets: Carbon steel.
 3. Tubes: Mechanically treated copper tubes fixed and aligned into intermediate tube support sheets across the shell to maintain consistent spacing between tubes with the capability of being cleanable.
 4. Working Pressure Rating, Refrigerant-Side: 200 psi.
 5. Working Pressure Rating, Water-Side: 150 psi.

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6. Cold Surface Insulation:
 - a. Factory install on shell and all other cold surfaces.
 - b. 0.75-inch minimum thickness, closed cell, expanded polyvinyl chloride flexible foam insulation with a maximum K factor of 0.28.
- D Provide vents and water drain connections.
- E Provide fittings for temperature control sensors.
- F Freeze Protection: Provide evaporator heater with thermostat to protect from freezing at ambient temperatures down to minus 20 degrees F.
- G Air-Cooled Condenser:
 1. Heat Exchanger:
 - a. Arrangement: Two pass, round tubes.
 - b. Mechanically bond aluminum fins to internally enhanced, seamless copper tubing and protect with corrosion resistant materials or coatings.
 - c. Clean, dehydrate and test.
 - d. Leak Test: 506 psi.
 - e. Seal: Nitrogen holding charge.
 2. Coil Guards: Provide expanded metal with lint screens. Protect condenser coil by enclosing with heavy plastic to prevent damage during shipping or rigging.
 3. Fans and Motors:
 - a. Dynamically balanced propeller type, direct drive fans of reinforced polymer corrosion resistant construction and equip with sealed, permanently lubricated ball bearings.
 - b. Discharge Fan Guards: Coated steel wire.
 - c. Discharge Direction: Vertical.
 - d. Motors: Totally enclosed, high efficiency, suitable for outdoor use, three phase, permanent split capacitor, single speed with internal overload protection.
- H Refrigeration Circuits:
 1. Provide two independent refrigeration circuit(s) with two compressor(s) per circuit.
 2. Minimum Refrigerant Specialties per Circuit:
 - a. Isolation and service valves for refrigerant removal and charging.
 - b. Removable-core filter driers.
 - c. ASHRAE Std 15 compliant relief valves.
 - d. Liquid line sight glass with moisture indicator.
 - e. Refrigerant expansion valves or metering devices.
 - f. Complete operating charge of both refrigerant and oil.
- I Starters and Drives:
 1. Variable Frequency Drives: Completely assemble, wire, pipe, and factory test, factory or field mounted variable frequency drive (VFD). Limit the field electrical connections for compressor motor power to the main power leads to the VFD, wiring of liquid pumps and tower fans to the control panel.

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- a. Characteristics:
 - 1) Refrigerant cooled.
 - 2) Microprocessor based pulse width modulation (PWM) with input/output power devices, DC voltage rectifier, and inverter/control regulator to convert DC voltage to sinusoidal PWM waveform.
 - 3) Physically isolate low voltage control from main power sections.
 - 4) Control motor speed by integrated controls over wide range of operating conditions.
 - 5) Provide short circuit interrupt and withstand rating suitable for available current.
- b. Performance:
 - 1) Do not exceed IEEE 519 requirements for voltage total harmonic distortion (THD) and harmonic current total demand distortion (TDD) using VFD circuit breaker input terminals as the point of common coupling (PCC).
 - 2) Full Load Efficiency: Minimum 97 percent at 100 percent VFD rated capacity.
 - 3) Unity Displacement Power Factor: 0.99 minimum.
 - 4) Voltage Boost Capability: Full motor voltage at reduced line voltage conditions.
 - 5) Soft start, linear acceleration, and coast to stop capabilities.
 - 6) Base Motor Adjustable Frequency Range: Control to 15 percent capacity at nameplate voltage.
 - 7) Torque Generation: 150 percent instantaneous.
- c. Heat Sink and Mating Flange:
 - 1) Design for 185 psi waterside working pressure.
 - 2) Meter to maintain temperature within acceptable limits.
- d. Suitable Ratings:
 - 1) Operation at plus or minus 10 percent nameplate voltage.
 - 2) Continuous Operation at:
 - (a) 100 percent of nameplate amperes and 5 seconds at 15 percent.
 - (b) Ambient temperature range of 40 to 122 degrees F, 95 percent humidity noncondensing for altitudes up to 6,000 feet.
 - 3) Comply with NEMA EN 10250 and NEMA MG 00001.
- e. User Interface for Programming and Display of the Following Parameters:
 - 1) Operating, configuration and fault messages.
 - 2) Hertz frequency.
 - 3) VFD load, line side voltage, and current.
 - 4) kW.
 - 5) Input/output power devices temperature.
- f. Electrical Service, Single Point Power:
 - 1) Input Circuit Breaker: Suitable for the available current indicated.
 - 2) Provide power for chiller oil pump via factory wired standard branch circuit breaker.

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- 3) Provide power for oil heater, VFD and controls via 3 kVA control power transformer and factory wired circuit breaker.
- g. Discrete Dry-Contact Outputs:
 - 1) Circuit breaker shunt trip.
 - 2) Chilled water pump.
 - 3) Condenser water pump.
 - 4) Alarm status.
- h. Analog Outputs: 4 to 20 mA for head pressure reference and condenser water control valve as applicable.
- i. Provide protection for under/over-voltage, phase loss/reversal/unbalance, ground fault, single cycle voltage loss, programmable auto restart after power loss, and motor overload/over temperature protection.
- J Controls Package:
 - 1. Unit Controls: Factory-supplied DDC:
 - a. Control-panel mounted with required input-output expansions, power supply, fused disconnect, hand switches, knobs, and accessories required to control chiller unit to manufacturer required sequences to meet intended use with listed performance.
 - b. Factory configured to interface prewired sensors, switches, and safeties with allowance to add up to four chiller valves and flow sensors.
 - c. Graphic-based touchscreen to include unit operation controls and user filter based interface for faults, alarms, performance, unit diagnostics, and data recording up to 12 months.
 - d. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
 - e. External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.
 - f. Isolation Valves: Field-installed, 2-position, butterfly type with position tracking; see Section 25 3519.
 - 2. Control Components for Preventing Shutdown:
 - a. Provide high pressure limit with indicating light for each compressor, set lower than factory pressure switch to automatically unload compressor and prevent nuisance high pressure condenser control trip.
 - b. Provide one protector with indicating light for each compressor, with current limit setpoint of 120 percent of compressor running load amperage to automatically unload compressor preventing over-current trip.
 - c. Provide low refrigerant limit to automatically unload each compressor preventing a low evaporator temperature trip.
 - 3. Chiller Operation in Abnormal Operating Conditions:
 - a. Unloaded Running: Adequate chilled water production.

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- b. Trip-out Limit Reached: Chiller goes off-line and manual reset is required for continued operation.
 - 4. Control Panel Display:
 - a. Evaporator pressure.
 - b. Condenser refrigerant pressure.
 - c. Entering and leaving evaporator water temperature.
 - 5. Points for Remote Monitoring and Control:
 - a. Entering and leaving condenser water temperature as applicable.
 - b. Chilled water setpoint.
 - c. Electrical 3 phase current limit and percent RLA setpoint.
 - d. Electrical 3 phase amp draw.
 - e. Chiller operating mode.
 - f. Condenser refrigerant temperature.
 - g. Elapsed time and number of starts counter.
 - h. Chiller compressor run status relay.
 - i. Minimum of 20 diagnostics with time and date stamp.
 - j. Identification of the fault, date, time and operating mode at time of occurrence, type of reset required, and help message.
 - k. Relay output energized upon detecting a fault requiring manual reset.
 - l. Relay output energized whenever unit is operating in a limit mode for an extended period of time.
 - m. Analog input to control leaving chilled water temperature setpoint based upon a 4-20ma or 0-10 VDC signal from the building automation system.
 - n. Programmable soft during pull-down period via ramped current limit or fully adjustable, temperature pull-down rate.
 - o. Leaving chilled water reset based upon return water temperature.
 - p. Provide RS-232 for printer interface.
- K Electrical Characteristics (Single Point Power Connection):
 - 1. Electrical: NEMA EN 10250 or UL 1995 as applicable.
- L Accessories
 - 1. Provide and install thermal dispersion flow switch. DP switches not approved
 - 2. Low Sound Fans
 - 3. Provide compressor blankets and low sound option
 - 4. Provide BACnet MSTP or IP card as per DDC control protocol.
 - 5. Provide service isolation valves
 - 6. Provide Hail Guards.
 - 7. Provide removable/cleanable flexible air intake filter (Prevent Model U1 or Equal)

PART 3 EXECUTION

3.01 INSTALLATION

- A Install in accordance with manufacturer's instructions.

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- B Align chiller package on steel or concrete foundations.
- C Install units on vibration isolators.
- D Connect to electrical service.
- E Connect to chilled water piping.
- F Arrange piping for easy dismantling to permit tube cleaning and removal.
- G Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

3.02 FIELD QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.

3.03 MANUFACTURER'S FIELD SERVICES

- A Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.
- B Supply initial charge of refrigerant and oil if not completely factory charged.
- C Demonstrate system operations and verify specified performance.
- D Provide 36 month maintenance contract with chiller installation.

3.04 CLOSEOUT ACTIVITIES

- A Demonstrate proper operation of equipment to Owner's designated representative.
- B Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of one day of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

3.05 MAINTENANCE

- A Provide a separate maintenance contract for specified maintenance service.
- B Provide a separate maintenance contract for the service and maintenance of chillers for 3 years from Date of Substantial Completion.

END OF SECTION 23 6426

**SECTION 23 7313
MODULAR CENTRAL-STATION AIR-HANDLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Casing construction.
- B Fan section.
- C Motors
- D Coil section.
- E Filter and air cleaner section.
- F Damper section.
- G Access section.
- H Turning and discharge plenum section.
- I Controls.
- J Roof mounting curb.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings; 2015 (Reaffirmed 2020).
- B AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
- C AHRI 430 (I-P) - Performance Rating of Central Station Air-handling Unit Supply Fans; 2020.
- D AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- E AMCA 99 - Standards Handbook; 2025.
- F AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016.
- G AMCA 300 - Reverberant Room Method for Sound Testing of Fans; 2014.
- H AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.
- I AMCA 500-D - Laboratory Methods of Testing Dampers for Rating; 2018.
- J ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017, with Addendum (2022).
- K ASHRAE Std 62.1 - Ventilation for Acceptable Indoor Air Quality; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- L ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks; 2020, with Errata (2023).
- N ASTM B177/B177M - Standard Guide for Engineering Chromium Electroplating; 2011 (Reapproved 2021).

- O NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- P SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- Q UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D Manufacturer's Instructions: Include installation instructions.
- E Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.
- F Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Extra Filters: One set for each unit.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- B Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.
- C Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.08 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.

- B Provide minimum one year manufacturer warranty covering repair or replacement due to defective materials or workmanship.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A Carrier Global Corporation: www.carrier.com/#sle.
- B Daikin Applied; Vision: www.daikinapplied.com/#sle.
- C York, a brand of Johnson Controls International, PLC: www.york.com/#sle.
- D Nortec
- E Haakon
- F Pace

2.02 CASING CONSTRUCTION

- A Full Perimeter Base Rail:
 - 1. Construct of galvanized steel with standard manufacturers painted finish.
 - 2. Provide base rail of sufficient height to raise unit for external trapping of condensate drain pans.
- B Casing:
 - 1. Construct of one piece, insulated, double wall panels.
 - 2. Provide mid-span, no through metal, internal thermal break.
 - 3. Construct outer panels of galvanized steel and inner panels of galvanized steel.
 - 4. Casing Air Pressure Performance Requirements:
 - a. Able to withstand up to 8 in-wc positive or negative static pressure.
 - b. Not to exceed 0.0042 inches per inch deflection at 1.5 times design static pressure up to a maximum of plus 8 in-wc in positive pressure sections and minus 8 in-wc in negative pressure sections.
 - 5. Sound Baffles - Secured to inner liner on all discharge plenum, return air plenum, and fan sections.
 - a. Provide perforated galvanized steel
 - b. High density fiberglass insulation with melamine
- C Access Doors:
 - 1. Construction, thermal and air pressure performance same as casing.
 - 2. Provide surface mounted handles on hinged, swing doors.
 - 3. Provide shatterproof viewing window designed to withstand operating pressures on all full height man doors.
- D Unit Flooring: Construct with sufficient strength to support expected people and equipment loads associated with maintenance activities. Minimum base rails shall be 5" in height.
- E Casing Leakage: Seal joints and provide airtight access doors so that air leakage does not exceed one percent of design flow at the specified casing pressure.
- F Insulation:
 - 1. Provide minimum thermal thickness of 12 R throughout.

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2. Completely fill panel cavities in each direction to prevent voids and settling.
3. Comply with NFPA 90A.

G Drain Pan Construction:

1. Provide cooling coil and humidifier sections with an insulated, double wall, stainless steel drain pan complying with ASHRAE Std 62.1 for indoor air quality and sufficiently sized to collect all condensate.
2. Slope in two planes to promote positive drainage and eliminate stagnate water conditions.
3. Locate outlet of sufficient diameter at lowest point of pan to prevent overflow at normal operating conditions.
4. Provide threaded drain connections constructed of drain pan material, extended sufficient distance beyond the base to accommodate field installed, condensate drain trapping.

H Finish:

1. Indoor Units:
 - a. Provide exterior, galvanized steel panels with painted surface complying with ASTM B177/B177M.
 - b. Color: Manufacturer's standard color.
 - c. Finish shall meet the 1000 hour salt spray as per ASTM 117B

2.03 FAN SECTION

- A** Type: Air foil, single width, single inlet, centrifugal plug fan, in accordance with AMCA 99. . All fans shall be specified in drawing schedules as per type, drive, HP and quantity.

1. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96, for fan application class BV-5, to meet or exceed a rotational imbalance Grade G.55, producing a maximum rotational imbalance of 0.022 inches per second peak, filter in. "Filter in" measurement indicates that the specified balance grade must be achieved at the submitted design operating speed for the fan(s).
2. Fan and motor assemblies shall be designed for application in multiple fan arrays.

B Multiple Fan Arrays

- C** The fan array shall consist of multiple housed fans or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air tunnel cross section and components contained therein.

1. Each fan and motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor.
2. All fans in the multiple fan arrays shall be AMCA certified for performance per AMCA arrangement "A" testing configuration. The submitted fan performance shall be inclusive of system effects attributed to the fan mounting arrangement, fan enclosures, back draft dampers, and other fan appurtenances not considered when AMCA certified performance per AMCA arr. "A" is determined. Submitted AHU/fan performance that does not indicate allowances for system effects for the back flow prevention device(s), wheel enclosures, safety screens, bearing pedestals, belt guards, or the fan and motor enclosure in which

each fan is mounted, will be returned to the contractor disapproved and will need to be resubmitted with all of the requested information included for approval. Added system effects for acoustic attenuators, or other devices required to meet specified fan performance and sound levels must be indicated in the submitted fan selection data.

3. Fan system power requirements or sound power levels that fail to meet specified performance levels shall be corrected to meet specified performance levels at no additional cost to the owner. Any proposed corrections for power or sound deviations from specified values must be submitted to the engineer for approval prior to implementation of any proposed corrective procedure.
 4. Submittals for units providing less than the scheduled quantity of fans and/or spacing of the fans for multiple fan arrays shall submit CFD modeling of the air flow profile for approval that indicates uniform velocity and flow across all internal components without increasing the length of the AHU unit or changing the aspect ratio of the unit casing as designed.
 5. Manufacturers that do not manufacture their own fans for the specific purpose of use in multiple fan arrays, shall provide a letter guaranteeing submitted AHU performance for flow, pressure, and acoustics at the perimeter boundary of the unit signed by an officer of the OEM fan manufacturer being submitted. Any corrective acoustical treatment, added airway tunnel lengths, increased electrical service, and any structural modifications necessary to meet specified and scheduled performance shall be provided at no additional cost to the owner to meet the specified performance criteria.
- D Performance Ratings: Determined in accordance with AMCA 210 and labeled with AMCA Certified Rating Seal.
- E Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
- F Bearings: Self-aligning, grease lubricated, with lubrication fittings extended to exterior of casing with plastic tube and grease fitting rigidly attached to casing. Bearings shall be selected for an average minimum L-10 life of 40,000 hours
- G Mounting:
1. Locate fan and motor internally on welded steel base coated with corrosion resistant paint.
 2. Factory mount motor on slide rails.
 3. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors.
 4. Provide built-in inertia base of welded steel with bottom sheet and reinforcing grid for concrete ballast.
- H External Motor Junction Box: Factory mount NEMA 4 external junction box and connect to extended motor leads from internally mounted motors.
- I Motor Wiring Conduit: Factory wire fan motor wiring to the unit mounted starter-disconnect, variable frequency drive, and external motor junction box.
- J Fan Accessories:
- K Flexible Duct Connections:

1. For separating fan, coil, and adjacent sections.
 2. The connectors shall be manufactured of heavy gauge glass fabric, double coated with neoprene and a minimum of 6" in length.
- L Supply Fan Performance Complying with AHRI 430 (I-P):
1. Fan sections consist of housing, wheel, fan shaft, bearing, motor, drive assembly and support structure. Fans shall be selected not to exceed an RPM rating higher than 90% of the maximum class RPM
- M Return Fan Performance Complying with AHRI 430 (I-P):
1. Fan sections consist of housing, wheel, fan shaft, bearing, motor, drive assembly and support structure. Fans shall be selected not to exceed an RPM rating higher than 90% of the maximum class RPM
- N Drives:
1. Comply with AMCA 99.
 2. Bearings: Heavy duty pillow block type, ball bearings, with ABMA STD 9 L-10 life at 50,000 hours.
 3. Shafts: Shafts are to be ASTM A-108 Grade 1040/1045, precision tuned, ground and polished, with key-way, and protectively coated with lubricating oil. Grade 1018 Steel not approved.
 4. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Variable and adjustable pitch sheaves for motors 15 hp and under selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp and over, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor.
 5. Belt Guard: Fabricate to SMACNA (DCS); 0.106 inch thick, 3/4 inch diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

2.04 MOTORS

- A Premium or Ultra Premium Efficiency
- B AC Motors:
1. All motors shall be standard foot mounted type, TEFC or TEAO motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere.
 2. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2.
 3. Motors shall be as manufactured by Baldor, Siemens, or Toshiba. Motors shall be available in 1/2 HP increments at nameplate HP ratings from 1.5 HP through 12 HP.
 4. All motors shall include permanently sealed bearings and shaft grounding means to protect the motor bearings from electrical discharge machining due to stray shaft current. Motors provided with hybrid ceramic bearings, when specified, do not require shaft grounding devices.
 5. Steel cased motors and/or ODP motors are not acceptable

C Electronically Commutated Permanent magnet motors (ECMi)

1. All ECMi motors shall be UL listed with brushless permanent magnet motors.
2. All bearings shall be permanently lubricated
3. Motors shall have a design life of L10 100,000 hours
4. Motors shall have a means of shaft isolation to prevent electrical arcing across bearings
5. Motors shall be complete with electronic motor overload protection, locked rotor protection and thermal management
6. Motors shall meet IP54 protection and thermal class THCL 155.
7. Modbus communication option available

2.05 COIL SECTION

- A Casing:** Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
- B Drain Pans:** 24 inch downstream of coil and down spouts for cooling coil banks more than one coil high.
- C Eliminators:** Three break of galvanized steel, mounted over drain pan.
- D Air Coils:**
1. Certify capacities, pressure drops, and selection procedures in accordance with AHRI 410.
- E Fabrication:**
1. Tubes: 5/8 inch OD seamless copper expanded into fins, brazed joints.
 2. Fins: Aluminum.
 3. Casing: Die formed channel frame of galvanized steel.
- F Water Heating Coils:**
1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
- G Water Cooling Coils:**
1. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 2. Configuration: Drainable, with threaded plugs for drain and vent; threaded plugs in return bends and in headers opposite each tube.

2.06 HOSE KITS AND VALVES

- A Manufacturers:**
1. Griswold Controls: www.griswoldcontrols.com/#sle.
 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 3. Proflow
- B Hoses:**
1. Provide hoses for all units for connection to main water supply and return headers.
 2. Length: 2 feet.
 3. Material: Braided stainless steel rated to minimum 400 psi at 265 degrees F.

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- C Manual Balancing Valves:
 - 1. Brass body for shutoff and hydronic balancing.
- D Ball Valves:
 - 1. Brass body for shutoff and hydronic balancing.
 - 2. Provide pressure/temperature ports.
 - 3. Provide balancing valves.
- E Y Strainers:
 - 1. Bronze body.
 - 2. "Y" type configuration with brass cap.
 - 3. Maximum Operating Pressure: Minimum 450 psi.
 - 4. Screen: Stainless steel.

2.07 FILTER AND AIR CLEANER SECTION

- A General: Provide filter sections with filter racks, minimum of one access door for filter removal, and filter block-offs to prevent air bypass.
- B Hi-Efficiency Filters:
 - 1. Media: 2 inch prefilter and 4 inch closely spaced, pleated, fine fiber, hi-efficiency filter, sealed into a rigid frame, and capable of operating up to a maximum of 625 fpm without loss of efficiency and holding capacity.
 - 2. Filter Rack: Side-access designed to hold rigid frames.
 - 3. Minimum Efficiency Reporting Value: 11 MERV when tested in accordance with ASHRAE Std 52.2.
- C Differential Pressure Gauge:
 - 1. Provide factory installed dial type differential pressure gauge, flush mounted with casing outer wall, and fully piped to both sides of each filter to indicate status.
 - 2. Maintain plus/minus 5 percent accuracy within operating limits of 20 degrees F to 120 degrees F.

2.08 DAMPER SECTION

- A Mixing Section: Provide a functional section to support the damper assembly for modulating the volume of outdoor, return, and exhaust air.
- B Maximim face velocity through dampers is 1500 fpm.
- C Damper Blades:
 - 1. Double-skin airfoil design with metal, compressible jamb seals and extruded-vinyl blade-edge seals on each blade.
 - 2. Self-lubricating stainless steel or synthetic sleeve bearings.
 - 3. Comply with ASHRAE Std 90.1 I-P for rated maximum leakage rate.
 - 4. Provide leakage testing and pressure ratings in compliance with AMCA 500-D test methods.
 - 5. Arrange in parallel or opposed-blade configuration.
- D Barometric Relief Dampers:

1. Frame: Roll formed galvanized steel.
2. Blades: Roll formed galvanized steel.
3. Blade Seals: Extruded vinyl, mechanically attached to the blade edge.
4. Material:
 - a. Galvanized steel, single tie bar linkage for damper sections up to 24 inches wide.

2.09 ACCESS SECTION

- A Provide where indicated on drawings to allow for inspection, cleaning, and maintenance of field-installed components.
- B Construct access doors same as previously specified within this Section.

2.10 INTERNAL NOISE CONTROL - SOUND BAFFLES

- A In addition to double wall construction provide baffle sound attenuation in the following sections;
 1. Discharge Plenum(s)
 2. Return Plenum(s)
 3. Exhaust Plenum(s)
 4. Fan Array Sections
 5. Access Sections
- B In the absence of Discharge, Return, or Exhaust Plenum provide attenuated elbows and plenums.

2.11 TURNING AND DISCHARGE ELBOWS

- A Provide plenum to efficiently turn and discharge air.
 1. Scale plenum vertical height to accommodate discharge duct height.
 2. Scale plenum horizontal length to accommodate required dimensional constraints.
- B Acoustical Liner:
 1. Fabricate from corrosion-proof, perforated galvanized steel with completely encapsulated fiberglass insulation.
 2. Prevent breakaway, flake off, or delamination when tested at 9000 fpm in accordance with UL 181.

2.12 CONTROLS

- A Combination VFD - Disconnects:
 1. Provide factory mounted, combination VFD - disconnect for each fan motor.
 2. Mount VFD-disconnect on fan section externally in a NEMA 1 enclosure within a dedicated controls section or housed fan section.
 3. Mount VFT-disconnects on fan section externally in NEMA 3R minimum for all outdoor units. Cabinets shall be ventilated and heated to maintain electronic temperature requirements
- B BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135 BACnet MS/TP.
- C External Point Mapping: Provide mapping table for each parameter included in the local visual interface with software-toggle flag to allow reduced mapping of available points.

2.13 ROOF MOUNTING CURB

- A Roof Vibration Isolation Mounting Curb: 24 inches high galvanized steel, channel frame with gaskets and nailer strips.
- B Vibration Isolation shall be provided between curb and roof deck with continuous isolation pads with minimum thickness of approximately 2" Mason SW pads or equal.
- C Provide clips from unit to roof curb.
- D Include roof curb accessories for each roof mounted unit.

PART 3 EXECUTION**3.01 INSTALLATION**

- A Install in accordance with manufacturer's instructions.
- B Bolt sections together with gaskets.
- C Provide sheaves required for final air balance.
- D Make connections to coils with unions or flanges.
- E Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Provide manual air vents at high points complete with stop valve.
 - 5. Ensure water coils are drainable and provide drain connection at low points.

3.02 FIELD QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.

3.03 SYSTEM STARTUP

- A Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.

3.04 CLOSEOUT ACTIVITIES

- A Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Briefly describe function, operation, and maintenance of each component.

END OF SECTION 23 7313

SECTION 23 7313.16
INDOOR, SEMI-CUSTOM AIR HANDLING UNITS**PART 1 GENERAL (AHU-5 AND AHU-6)****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 Section includes insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components, including the following:
 1. Casings.
 2. Fans, drives, and motors.
 3. Coils.
 4. Air filtration.
 5. Dampers.
 6. Air-to-air energy recovery.

1.03 ACTION SUBMITTALS

- A Product Data: For each air-handling unit.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 3. Include unit dimensions and weight.
 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 5. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated.
 - b. Include certified fan-sound power ratings.
 - c. Include fan construction and accessories.
 - d. Include motor ratings, electrical characteristics, and motor accessories.
 6. Include certified coil-performance ratings with system operating conditions indicated.
 7. Include filters with performance characteristics.
 8. Include dampers, including housings, linkages, and operators.
- B Shop Drawings: For each type and configuration of indoor, semi-custom air handling unit.
 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. Detail fabrication and assembly of indoor, semi-custom air-handling units, as well as procedures and diagrams.
 4. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B Source quality-control reports.
- C Startup service reports.
- D Field quality-control reports.
- E Sample Warranty: For manufacturer's warranty.

1.05 CLOSEOUT SUBMITTALS

- A Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.06 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. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.

1.07 WARRANTY

- A Warranty: Manufacturer agrees to repair or replace components of indoor, semi-custom air-handling units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 PRODUCTS**2.01 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 NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E Delegated Design: Engage a qualified professional engineer, as defined in Section 01 4000 "Quality Requirements," to design vibration isolation, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- F Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 8-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.
- G Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg.

2.02 CAPACITIES AND CHARACTERISTICS – SEE DRAWING SCHEDULE FOR DETAILS**2.03 MANUFACTURERS**

- A Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carrier Global Corporation.
 2. Daikin Applied.
 3. Innovent.
 4. YORK; brand of Johnson Controls International plc, Building Solutions North America.
 5. Pace
 6. Haakon

2.04 UNIT CASINGS

- A Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.
- B Base Rail:
1. Material: Welded structural steel.
 2. Height: 8 inches.
- C Casing Joints: Hermetically sealed at each corner and around entire perimeter.
- D Double-Wall Construction:
1. Outside and Inside Casing Wall:
 - a. Material, 5052-H32 mill-finished aluminum.
 - b. Factory Finish: Provide manufacturer's standard finish.
- E Floor Plate:
1. Material, Aluminum: minimum 14 gauge thick.
- F Casing Insulation:
1. Materials: Injected polyurethane foam insulation.
 2. Casing Panel R-Value: Minimum R-11.
 3. Insulation Thickness: 2 inches.
 4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- G Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- H Static-Pressure Classifications:
1. For Unit Sections Upstream of Fans: Minus 2-inch wg.
 2. For Unit Sections Downstream and Including Fans: 4-inch wg.
- I Panels, Doors, and Windows:
1. Panels:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow

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- c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
- 2. Doors:
 - a. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
 - b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.
- 3. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Coil Section: Panels.
 - c. Access Section: Doors.
 - d. Access Sections Immediately Upstream and Downstream of Coil Sections: Doors.
 - e. Damper Section: Doors.
 - f. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - g. Access Sections Immediately Upstream and Downstream of Filter Sections: Doors.
 - h. Mixing Section: Doors.
- J Condensate Drain Pans:
 - 1. Construction:
 - a. Double-wall, 5052-H32 mill-finished aluminum sheet with space between walls filled with foam insulation and moisture-tight seal.
 - 2. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - b. Minimum Connection Size: NPS 2.
 - 3. Slope: Minimum 0.125-in./ft. slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - 4. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 - 5. Width: Entire width of water producing device.
 - 6. Depth: A minimum of 2 inches deep.

7. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.05 FAN, DRIVE, AND MOTOR SECTION

- A Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 - 3. Plenum Fan Arrays: Uncontained as defined in AHRI 430. Steel or aluminum frame with inlet cone and structural framing around each fan built into an array of multiple fans. All steel parts shall be cleaned and coated with 1000 hour salt spray finish.
 - 4. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; aluminum hub riveted to backplate and fastened to shaft with setscrews.
 - 5. Shaft Lubrication Lines: Extended to a location outside the casing.
 - 6. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.032-inch-thick, aluminum sheets.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
 - 1) Fabric Minimum Weight: 26 oz./sq. yd..
 - 2) Fabric Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3) Fabric Minimum Service Temperature Range: Minus 40 to plus 200 deg F.
- C Drive, Direct: Factory-mounted, direct drive.
- D Motors:
 - 1. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."
 - 2. 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.
 - 3. Enclosure Type: Totally enclosed, fan cooled.
 - 4. Enclosure Materials: Cast iron.
 - 5. Unusual Service Conditions:
 - a. High humidity.
 - 6. Efficiency: Premium Efficient motors as defined in NEMA MG 1.
 - 7. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

8. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

E Comply with Section 26 2923 "Variable-Frequency Motor Controllers."

2.06 COIL SECTION

A General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.

B Preheat and Heating Coils:

1. Hot-Water Coils:
 - a. Piping Connections: Threaded, same end of coil.
 - b. Tube Material: Copper.
 - c. Fin Type: Plate.
 - d. Fin Material: Aluminum.
 - e. Fin Spacing: Maximum 10 fins per inch.
 - f. Fin and Tube Joint: Mechanical bond.
 - g. Headers:
 - 1) Seamless copper tube with brazed joints, prime coated.
 - h. Frames: Channel frame, 0.052-inch-thick, galvanized steel.
 - i. Coil Working-Pressure Ratings: 200 psig, 325 deg F.

C Cooling Coils:

1. Chilled-Water Coil: Self-draining.
 - a. Piping Connections: Threaded, same end of coil.
 - b. Tube Material: Copper.
 - c. Fin Type: Plate.
 - d. Fin Material: Aluminum.
 - e. Fin Spacing: 12 FPI
 - f. Fin and Tube Joint: Mechanical bond.
 - g. Headers:
 - 1) Seamless copper tube with brazed joints, prime coated.
 - h. Frames: Channel frame, 0.064-inch-thick, galvanized steel.
 - i. Working-Pressure Ratings: 200 psig, 325 deg F.

2.07 AIR FILTRATION SECTION

A Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive.

B Side-Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. Aluminum track.
 - a. Prefilters: Incorporate an integral 2-inch-thick track with same access as primary filter.
 - b. Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.
2. HEPA Filter Frames:
 - a. Frames: Match inner casing and outer casing material, and insulation thickness. Aluminum track.
 - b. Prefilters: Incorporate an integral 4-inch-thick track,
 - c. Sealing: Incorporate positive-sealing clamping device on each filter between gasket seal on all sides of filter cartridge frames to prevent bypass of unfiltered air.

2.08 DAMPERS

- A Dampers: Comply with requirements in Section 23 0923.12 "Control Dampers."
- B Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in stainless steel sleeve bearings mounted in a single aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg, tested, rated, and labeled in accordance with AMCA 511.
- C Electronic Damper Operators:
 1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 23 0513 "Common Motor Requirements for HVAC Equipment."
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 inch. x lbf and breakaway torque of 300 inch. x lbf.
 5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 inch. x lbf.
 6. Size dampers for running torque calculated as follows:

- a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 10. Power Requirements (Two-Position Spring Return): 24 V dc.
 11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
 12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 13. Temperature Rating: Minus 22 to plus 122 deg F.
 14. Run Time: 30 seconds.
- D Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
- E Combination Filter and Mixing Section:
1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throwaway filters.

2.09 AIR-TO-AIR ENERGY RECOVERY UNITS

- A Fixed-Plate Sensible Heat Exchangers:
1. Casing: 3003 Aluminum. 8 Mil thickness
 2. Plates: Evenly spaced and sealed and arranged for cross airflow.
 3. Plate Material: Embossed aluminum.
 4. Bypass: Plenum within casing, with gasketed face-and-bypass dampers that have operating rods extended outside casing.
 5. Heat-Exchanger Prefilters: 2 inches thick, disposable MERV 6.

2.10 MATERIALS

- A Aluminum: ASTM B 09.
- B Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 1000 hour salt-spray test according to ASTM B117.
1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 inch-lb.
 - c. ASTM B3359 for cross hatch adhesion of 5B.
 2. Application: Immersion.

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3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.11 SOURCE QUALITY CONTROL

- A AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.
- B AHRI 1060 Certification: Test, rate, and label air-handling units that include air-to-air energy recovery devices in accordance with AHRI 1060.
- C AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.
- D Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.
- E Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- F Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- G Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

PART 3 EXECUTION

3.01 EXAMINATION

- A Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A Equipment Mounting: Base rail shall be high enough to provide adequate condensate trap. If unit does not have adequate height. Provide structural steel or concrete pad.
- B Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 PIPING CONNECTIONS

- A Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B Where installing piping adjacent to air-handling unit, allow for service and maintenance.
- C Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D Connect condensate drain pans using PVC. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

- E Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 2113 "Hydronic Piping" and Section 23 2116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

3.04 ELECTRICAL CONNECTIONS

- A Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- B Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 0553 "Identification for Electrical Systems."
 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.05 CONTROL CONNECTIONS

- A Install control and electrical power wiring to field-mounted control devices.

3.06 STARTUP SERVICE

- A Perform startup service in conjunction with commissioning agent.
1. Complete installation and startup checks according to manufacturer's written instructions.
 2. Verify that shipping, blocking, and bracing are removed.
 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 6. Verify that zone dampers fully open and close for each zone.
 7. Verify that face-and-bypass dampers provide full face flow.
 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 9. Comb coil fins for parallel orientation.
 10. Verify that proper thermal-overload protection is installed for electric coils.
 11. Install new, clean filters.
 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B Starting procedures for air-handling units include the following:
1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 2. Measure and record motor electrical values for voltage and amperage.
 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.07 ADJUSTING

- A Adjust damper linkages for proper damper operation.
- B Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
- C Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

3.08 CLEANING

- A After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.09 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 commissioning agent
 1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
 2. Charge refrigerant coils with refrigerant and test for leaks.
 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. HEPA Filters: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.
 5. HEPA Filters, Critical Applications: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter for air leaks according to ASME AG-1, pressure-decay method.
 6. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E Prepare test and inspection reports.

END OF SECTION 23 7313.16

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**SECTION 23 7340
AIR ROTATION UNITS**

PART 1 GENERAL

1.01 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; 2027.

1.02 SUMMARY

- A Section Includes:
 - 1. Air Rotation Units.

1.03 REFERENCES

- A National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
- B Underwriters Laboratory:
 - 1. The unit shall be manufactured and installed in accordance with the requirements of the Underwriters Laboratory standard; "Ductless Large Open Building Heating and Cooling Equipment - Category LZPG" and bear the official UL Label.

1.04 SUBMITTALS

- A Submittal Procedures: Submittals of all equipment drawings, schedules and specifications must accompany quote.
- B Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
- C Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- D Manufacturer's Installation Instructions: Submit/Indicate rigging and assembly.
- E Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 CLOSEOUT SUBMITTALS

- A Execution Requirements: Closeout procedures.
- B Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.
- C Operation and Maintenance Data: Submit two (2) bound copies of manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.06 QUALIFICATIONS

- A Manufacturer: Company specializing in manufacturing products specified in this section with minimum fifteen years documented experience.

1.07 WARRANTY

- A Execution Requirements: Product warranties and product bonds.
- B Furnish 10-year manufacturer warranty on heat exchangers.

- C Furnish one (3) year manufacturer parts only warranty for all equipment.

PART 2 PRODUCTS

2.01 AIR ROTATION UNITS

- A Manufacturers:
1. Johnson-Marcraft
- B Self-contained, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
1. The unit shall be designed for indoor/outdoor mounting. The unit will have the capabilities of heating, filtering, and circulating as detailed in the submittal drawing.
 2. The unit shall be factory assembled and tested prior to shipping and disassemble for shipping and reassembled on site by the awarded contractor as required.
 3. System and accessories to be UL listed and approved as a complete unit. Unit shall be manufactured to FM standards as required.
 4. Heating: Hot water coil
 5. Unit Configuration: Vertical with horizontal discharge.
 6. Units shall have control panel serviceable from ground level.
 7. Lifting Provisions: Lifting provisions shall be included on all units as an integral part of the equipment.
 8. Supply Voltage: 460V, 3ph., 60 Hz
 9. Control Voltage: 120 or 24 volt, 1ph, 60 Hz coordinate with controls contractor
 10. The unit shall have a single point electrical connection.
- C Frame Construction: Shall be angle iron framing with 3/16" horizontal flange and 1/8" vertical framing and factory painted, suitably reinforced and braced to permit the loading, shipping, unloading and rigging to the unit location and general handling of completed sections without damage to external or internal components or misalignment of factory assembled components due to normal handling techniques.
- D Cabinet Construction: 18-gauge A-60 bonderized steel suitable for factory painting. The panels shall be factory assembled using flat bar screwed construction and have a reinforced steel angle flange assembly. Unit shall be factory painted using factory standard enamel finish.
- E Access Panels: Hinged access doors in the unit housing shall be provided to permit ready access to all internal components. The access doors shall be a minimum of 18-gauge-galvanized steel. The doors shall be designed to swing out. The doors shall be provided with a continuous 16-gauge stainless steel piano hinge. The unit's wall panels shall be an integral part of the doorframe. The unit's fan compartment access for inspection and adjustment shall be UL approved. A warning placard shall be affixed at the access door indicating that the unit is to be shut off before opening the door and entering the fan compartment.
- F Return Air Filter Frame and Air Filters: Filter frame shall be fabricated of 16-gauge-galvanized steel and painted to match the unit's color. Filters shall be upstream service, mounted at floor level for ease of access. Filters will be 65% efficient pleated throwaway type (MERV-14, or equivalent).

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- G Filter Maintenance Indication: Dwyer Magnehelic gauge with factory setting to indicate filter change.
- H Double-Wall Insulation: Sections for inlet, outlet and fan section of the Air Rotation unit shall be double-wall insulated. 2" 3# density thermal liner with minimum 22 gauge galvanized perforated interior liner.
- I Supply Fans:
1. The supply fans, a minimum of two per unit, shall be airfoil premium propeller type with low-noise blades and a smooth inlet venturi. The pitch of the fan blades shall be field adjustable for ease of air flow adjustment and removal / replacement in case of fan failure. The propeller blades shall be supported by two bearings, which shall be of a self-aligning, ball bearing type and shall be designed for at least 100,000 hours average life.
 2. Fans shall have the capacity, and class, as scheduled.
 3. Blower Shafts - Blower shafts shall be solid ground and polished. The shafts shall not pass through their first critical speed when the unit comes up to the rated RPM. Shaft shall be coated with a rust inhibitor.
 4. V-Belt Drives - All V-belt drives shall be standard capacity dual belt type, furnished in matched sets with reinforced rubber belts. The sheaves shall be of a cast iron type.
 5. The service factor used for V-belt drive selection shall be not less than 1.25.
 6. Lubrication - Mount all grease fittings directly on the bearings.
 7. Motors shall be ODP, 1800 RPM, 460 volt, 3 phase, 60 Hz. Motor horsepower shall be as indicated on the schedule. Motors will be manufacturer's premium efficiency design.
- J Water Coils
1. Capacity – See schedule
- K Discharge Louvers: Vertical and horizontal louvers painted to match cabinet finish.
- L Accessories:
1. Freight to job site and factory-assisted start-up services shall be included with all bids.
- M Markings
1. The unit nameplate contain unit model number, serial number, full load amps, and supply voltage
 2. The units shall be permanently marked with the equipment number ATU-# as identified in the performance section.
 3. All matching pieces of units shipped in sections shall be marked for easy identification of adjoining sections.
 4. Proper warning labels for high voltage and moving parts shall be permanently affixed to access doors.
 5. An electrical ladder diagram shall be permanently affixed inside of the electrical control panel. The schematic shall be specific to the project and not be a generic type encompassing features or options not present on the unit. The schematic shall include the fuse replacement values and types.
- N Technical Field Service/Start-up:

1. The services of a factory trained Field Engineer will be provided at no extra cost to owner to supervise placing the system in operation and good adjustment. The Field Engineer will instruct the owner's personnel in good equipment operation, and review maintenance procedures with owner's qualified personnel or representatives.
2. The start-up shall include but not be limited to:
3. Verification of proper supply power and fuel.
4. Verification that electrical terminals are secure.
5. Proper Airflow balance.
6. Testing of all safety and operating controls.

PART 3 - EXECUTION

3.01 EXAMINATION

- A Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
- D Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

- A Arrange installation of units to provide access space around air-handling units for service and maintenance.
- B Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- C Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.03 PIPING CONNECTIONS

- A Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B Where installing piping adjacent to air-handling unit, allow for service and maintenance.
- C Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D Connect condensate drain pans using PVC. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 23 2113 "Hydronic Piping" and Section 23 2116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

3.04 ELECTRICAL CONNECTIONS

- A Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

- B Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 26 0553 "Identification for Electrical Systems."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.05 CONTROL CONNECTIONS

- A Install control and electrical power wiring to field-mounted control devices.

3.06 STARTUP SERVICE

- A Perform startup service in conjunction with commissioning agent.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that zone dampers fully open and close for each zone.
 - 7. Verify that face-and-bypass dampers provide full face flow.
 - 8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 - 9. Comb coil fins for parallel orientation.
 - 10. Verify that proper thermal-overload protection is installed for electric coils.
 - 11. Install new, clean filters.
 - 12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.
- B Starting procedures for air rotation units shall include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.07 ADJUSTING

- A Adjust dampers for proper damper operation.
- B Comply with requirements in Section 23 0593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
- C Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions.

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3.08 CLEANING

- A After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.09 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 commissioning agent
 - 1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E Prepare test and inspection reports.

END OF SECTION 23 7340

SECTION 23 7416
PACKAGED ROOFTOP AIR-CONDITIONING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Packaged, small-capacity, rooftop air-conditioning units.
- B Packaged, intermediate-capacity, rooftop air-conditioning units.
- C Packaged, large-capacity, rooftop air-conditioning units.

1.02 RELATED REQUIREMENTS

- A Section 23 0548 - Vibration and Seismic Controls for HVAC.
- B Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

- A AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment; 2018.
- B UL 1812 - Ducted Heat Recovery Ventilators; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.
- C Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.
- D Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- E Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
- F Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements for additional provisions.
 - 2. Extra Filters: One set for each unit.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A Protect units from physical damage by storing off site until roof mounting curbs are in place and ready for immediate installation of units.

1.07 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Provide a five year warranty to include coverage for refrigeration compressors.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A AAON

- B Carrier Corporation
- C Johnson Controls International
- D Diakin
- E York
- F Rheem Manufacturing Company Inc: www.rheem.com/#sle.

2.02 PACKAGED, SMALL-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

- A General: Roof mounted units having gas burner and electric refrigeration that are 6 tons and smaller in capacity.
- B Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.
- C Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
- D Electrical Characteristics: See Drawing Schedule
- E Disconnect Switch: Factory mount disconnect switch in control panel.

2.03 PACKAGED, INTERMEDIATE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

- A General: Roof mounted units having gas burner and electric refrigeration that are 7.5 tons to 25 tons in capacity.
- B Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.
- C Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
- D Electrical Characteristics: See Drawing Schedule
- E Disconnect Switch: Factory mount disconnect switch in control panel.

2.04 PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

- A General: Roof mounted units having gas burner and electric refrigeration that are 25 tons and larger in capacity.
- B Description: Self-contained, packaged, factory assembled and prewired, consisting of cabinet and frame, supply fan, return fan, heat exchanger and burner, heat recovery coil, controls, air filters, refrigerant cooling coil and compressor, condenser coil and condenser fan.
- C Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.05 PERFORMANCE REQUIREMENTS - SEE DRAWING SCHEDULE**2.06 CASING**

- A Cabinet: Steel with baked enamel finish, including access doors with piano hinges and locking handle. Structural members to be minimum 18 gauge, 0.0478 inch, with access doors or panels of minimum 20 gauge, 0.0359 inch.
- B Insulation: One-inch thick, neoprene-coated glass fiber with edges protected from erosion.

2.07 FANS

- A Supply and Exhaust Fan: Forward curved centrifugal type, resiliently mounted with V-belt drive, adjustable variable pitch pulley, and rubber isolated hinge mounted. Provide with high efficiency motor or direct drive as indicated. Isolate complete fan assembly. See Section 23 0548.

2.08 BURNERS

- A Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shut-off, intermittent spark or glow coil ignition, flame-sensing device, and automatic 100 percent shutoff pilot.
- B Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.

2.09 EVAPORATOR COIL

- A Provide copper tube aluminum fin coil assembly with galvanized drain pan and connection.
- B Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

2.10 CONDENSER COIL

- A Provide copper tube aluminum fin coil assembly with subcooling rows and coil guard.
- B Provide direct drive propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Provide high efficiency fan motors.
- C Provide refrigerant pressure switches to cycle condenser fans.

2.11 COMPRESSORS

- A Provide hermetic compressors, 3600 rpm maximum, resiliently mounted with positive lubrication, crankcase heater, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B Five minute timed off circuit to delay compressor start.
- C Outdoor thermostat to energize compressor above 35 degrees F ambient.
- D Provide step capacity control by cycling multi-speed compressors.

2.12 MIXED AIR CASING

- A Dampers: Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper to fall to closed position. Relief dampers may be gravity balanced.
- B Gaskets: Provide tight fitting dampers with edge gaskets maximum leakage 5 percent at 2-inch pressure differential.
- C Damper Operator, Units 7.5 Ton Cooling Capacity and Larger: 24 volt with gear train sealed in oil with spring return on.
- D Mixed Air Controls: Maintain selected supply air temperature and return dampers to minimum position on call for heating and above 75 degrees F ambient, or when ambient air enthalpy exceeds return air enthalpy.

2.13 TOTAL ENERGY RECOVERY WHEEL SECTION

- A Certified in accordance with AHRI 1060 (I-P) and UL 1812 for mechanical, electrical, and fire safety.
- B Wheel Construction:
 - 1. Dessicant Properties:
 - a. Factory coated.
 - b. Washable using standard detergent or alkaline based coil cleaner.
 - c. Resistant to high levels of humidity.
 - 2. Construct housing of stainless steel, aluminum, or galvanized steel.
 - 3. Factory set adjustable diameter seals and self-adjusting perimeter seals.
 - 4. Permanently sealed and lubricated wheel bearings.
 - 5. Motor:
 - a. Thermally protected.
 - b. Factory mounted.
- C Maintenance and Access Features:
 - 1. Access doors upstream and downstream of the wheel cassette.
 - 2. Removable wheel segments to facilitate maintenance and cleaning.
 - 3. Adequate space for cleaning, service, and maintenance.
- D Controls:
 - 1. Wheel Control: Damper control of recovery capacity to 40 percent of initial total recovery capacity.
 - 2. Frost Prevention Control: Provide outside air bypass or variable speed method.

2.14 AIR FILTERS:

- A 2-inch thick, glass fiber disposable media in metal frames.

2.15 OPERATING CONTROLS

- A Provide low voltage, adjustable room thermostat to control burner operation, compressor and condenser fan, and supply fan to maintain temperature setting.
 - 1. Include system selector switch heat-off-cool and auto-on fan control switch.
- B Provide remote-mounted auto-on fan control switch.

2.16 OPERATING CONTROLS - SINGLE ZONE UNITS

- A Electric solid state microcomputer-based room thermostat, located as indicated in service area with remote sensor located as indicated in service area with remote sensor.
- B Room thermostat to incorporate:
 - 1. Automatic switching from heating to cooling.
 - 2. Set up for four separate temperatures per day.
 - 3. Short cycle protection.
 - 4. Switch selection features including imperial or metric display, 12- or 24-hour clock, keyboard disable, remote sensor, fan on-auto.
- C Room thermostat display to include:
 - 1. Actual room temperature.

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2. Programmed temperature.
3. Programmed time.
4. Duration of timed override.
5. Time of day.
6. Day of week.
7. System model indication: heating, cooling, auto, off, fan auto, fan on.
8. Stage heating or cooling operation.

2.17 OPERATING CONTROLS - VARIABLE VOLUME UNITS

- A Temperature transmitter located in supply air to signal electronic logic panel to control mixing dampers and cooling in sequence. Mixing section to operate as first stage of cooling and revert to minimum outside air above approximately 75 degrees F as determined by enthalpy of return and outdoor air.
- B Control cooling by cycling compressors, cylinder unloading, and hot gas bypass.
- C Control logic to allow supply air reset under low load or airflow conditions.

PART 3 EXECUTION

3.01 EXAMINATION

- A Verify that roof is ready to receive work and opening dimensions are as required by manufacturer.
- B Verify that proper power supply is available.

3.02 INSTALLATION

- A Install in accordance with manufacturer's instructions.

3.03 SYSTEM STARTUP

- A Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

3.05 MAINTENANCE

- A Provide service and maintenance of packaged rooftop units for one year from Date of Substantial Completion.
- B Provide routine maintenance service with a two-month interval as maximum time period between calls.
- C Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of two filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.
- D Provide 24-hour emergency service on breakdowns and malfunctions.
- E After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION 23 7416

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SECTION 23 7425
PACKAGED GAS FIRED DESICCANT DEHUMIDIFIERS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
- B ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- C ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- D NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- E UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.
- F UL 795 - Commercial-Industrial Gas Heating Equipment; Current Edition, Including All Revisions.
- G UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.02 SUMMARY

- A This section includes factory designed, assembled, tested and packaged desiccant dehumidification units
- B The unit shall be designed specifically for indoor or outdoor mounting, as scheduled, and have a rectangular silhouette.
- C The unit shall be designed for (curb), (slab) or (steel dunnage) mounting.

1.03 PERFORMANCE

- A The unit shall be designed specifically to meet the unique dehumidification and ventilation operational requirements of the Ice Arena or Curling application.
- B Desiccant rotor shall be sized for full airflow capacity, without the necessity for bypass airstreams, unless required by specific project requirements.

1.04 SUBMITTALS

- A Data to be provided:
 - 1. Certified fan-performance curves with system operating conditions indicated.
 - 2. Certified fan-sound power ratings
 - 3. Motor ratings, electrical characteristics, motor and fan accessories
 - 4. Material gauges and finishes.
 - 5. Filters and their performance characteristics
 - 6. Dampers, including housings linkages, and operators
 - 7. Control components.
 - 8. Desiccant rotor performance data with system operating conditions
 - 9. Detailing dimensions, required clearances, components, Unit weight, method of field assembly, and location and size of each field connection.
 - 10. Applicable utility requirements: gas, electrical, steam, hot-water, etc.
 - 11. Airflow static pressure drops for each component.

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12. Owner and contractor responsibilities list that details rigging, field installation requirements to communicate activities that are to be field coordinated, provided, and supplied by others.

B Submittal Data Availability:

1. All submittal data shall be available electronically. Plan and elevation views of the units shall be in scale and shall be complete with internal scaled components.

1.05 QUALITY CONTROL

- A The unit assembly shall carry an ETL Label and be constructed in accordance to UL 1995 or equivalent standard. All features and options shall be included in the listing, including controls shipped loose.

B Manufacturer's Qualifications:

1. Manufacturer shall have a minimum of 10 years experience producing substantially similar equipment, and shall be able to show evidence of at least 100 installations in satisfactory operation in Ice Arenas and or Curling Facilities for at least 5 years.

1.06 DELIVERY, STORAGE, AND HANDLING

A Delivery of Units:

1. Deliver units to the Site to ensure uninterrupted progress of the work.
2. Comply with manufacturer's recommendations for rigging of equipment.

B Storage of Units:

1. Units that are stored in an outdoor environment prior to installation will require the Contractor to provide protection from outdoor weather elements.
2. Store all units in such a manner as to permit easy access for unit inspection and/or identification. Keep all units off the ground, using pallets, platforms, or other supports.

C Acceptance at Site:

1. All boxes, crates and packages shall be inspected by Contractor/customer upon delivery to the Site. Contractor/customer shall note any damage or missing components on the Bill of Lading from the carrier at time of delivery. Contractor/customer shall also promptly notify Manufacturer, if any damaged equipment or lost components exist.

1.07 WARRANTY

- A Manufacturer warrants desiccant dehumidification unit to be free of defects in material and workmanship for 24 months from the date of factory shipment or 18 months from the date of start-up, whichever is less. Additionally, manufacturer warrants the rotor and drive system (excluding the motor) to be free of mechanical defects for 7 years. The last 5 years are prorated. Manufacturer shall only be liable under this warranty if the product is installed, maintained and used according to the directions furnished by the manufacturer.

PART 2 PRODUCTS

2.01 UNIT CONSTRUCTION (2" DOUBLE-WALL)

A DOUBLE-WALL

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1. Casing wall penetrations where required, shall be provided with a finished cover plate both on the interior and exterior of the unit casing. Additionally, any conduit passing through the unit casing shall be sealed to prevent air leakage.

B BASE FRAME CONSTRUCTION

1. Base frame shall be a single frame construction for supporting the casing and internal components.
2. Units to have structurally formed 12 gauge G-90 galvanized steel. Base frame to be fastened with bolt type fasteners. Welding shall not be used to prevent a corrosion initiation point. All frames shall be suitably reinforced and braced to permit, shipping and rigging. All frames are suitable for general handling of the unit without damage or misalignment of the external and internal components.
3. Removable lifting lugs sets shall be provided on the base. Lifting lug distance shall not exceed a distance of 100" on center.
4. The floor assembly shall be 16 gauge and 20 gauge G-90 galvanized sheet steel for the top and bottom of the floor deck, respectively. Fiberglass insulation 4" minimum nominal thickness shall be used to insulate the base. Minimum 4" deep 12 gauge formed channels shall be used in the floor for support. This floor shall sustain the equipment loading and normal maintenance loading for the unit.

C CASING CONSTRUCTION

1. Exterior and interior wall panels shall be a minimum of 16 gauge and 20 gauge G-90 galvanized steel, respectively. The panels shall be self-framing. The panels shall form a self-framing casing with no additional structural support required. All joints shall be caulked airtight with RTV silicone sealant.
2. Exterior roof deck panels and interior roof liner shall be a minimum of 16 Gauge G-90 galvanized steel. The roof shall have a minimum of 1 ½" standing seams securely fastened at intervals not exceeding 12 inches, caulked and sealed.
3. All wall and roof assemblies shall be insulated with 2" thick 3.0# density rigid fiberglass that is rot-proof and non-combustible. The insulation shall have a total R-Value not less than 9.
4. The 2" fiberglass insulation shall conform to 25/50 (per ASTM E84 and UL 723 and CAN/ULC S102-M88). Meets NFPA 90A and 90B.
5. All joints shall be caulked airtight with RTV sealant.
6. Closures around internal components shall be airtight and shall be minimum 16 Gauge thickness, G-90 galvanized steel.

D ACCESS DOOR CONSTRUCTION

1. Access doors in the unit housing shall be provided to permit ready access to internal components. Access doors shall be provided with an inner sheet of 24 gauge, G-90 galvanized steel to protect the insulation. Exterior of access doors shall be 24 gauge G-90 galvanized steel. Doors shall be designed to swing against the fan static pressure in all sections.

2. The doors shall be provided with stainless steel hinges and latches/handles operable from both the exterior and interior of the unit.
3. Door latches are linked on units greater than 68" tall, if access doors are 46" or taller; allowing tall doors to be opened without the use of a ladder and ensuring complete sealing of the door.
4. Perimeter frames shall be Extruded aluminum.
5. Perimeter frames shall include EPDM gasket for maximum air and water seal tightness.
6. A door-hook shall be provided on the piping and electrical vestibule doors.

2.02 OUTSIDE AIR INLET HOODS

- A Outside air source shall be furnished with either multiple or a single hood and bird screen, sized for no more than 500 FPM at maximum design air volume.
- B Hoods and bird-screen shall be 16 gauge, G-90 galvanized steel. "Chicken wire in lieu of bird-screen" shall not be acceptable.

2.03 DAMPERS

- A Damper frames and blades shall be 16 gauge galvanized steel with plated steel linkages and shafts to ensure a long, corrosion-free life.
- B The blades shall be 16 gauge galvanized steel with maximum single blade dimensions of 6" x 48". Blades shall be rigid at the design velocities.
- C Blade-to-blade linkage shall accurately control each blade without need for adjustment and be concealed within the frame and out of the airstream to protect linkage and reduce pressure drop and noise.
- D Axles shall be 1/2 inch. diameter square, plated steel, positively locked to the blades to eliminate slippage and include stainless steel bearings.
- E Dampers shall include extruded TPE blade seals and "arc" jamb seals which shall be flexible stainless steel, compression type. Leakage-rate shall meet or exceed Class 1 leakage as defined by AMCA Standard 500-D.
- F Damper to be provided with motorized actuator or manual locking quadrant.

2.04 MIXING BOX

- A The mixing box shall be capable of 100% OA or 100% RA or intermediate volumes as scheduled. The mixing box shall accommodate discrete outdoor air ventilation modes of "IAQ", "Low Occupancy", and "Unoccupied".
- B Shall include damper actuators, mounted and wired

2.05 FILTERS

- A Construction
 1. Filter media shall be a cotton and synthetic blend, lofted to a uniform depth, and formed into a uniform radial pleats. There shall be at least 10 pleats per linear foot for 2" thick filters.
 2. A welded wire grid, spot-welded on centers and treated for corrosion resistance, shall be bonded to the downstream side of the media to maintain the radial pleat and prevent media oscillation.

B Performance

1. The filter shall have a Minimum Efficiency Reporting Value of MERV 8 when evaluated under the guidelines of ASHRAE Standard 52.2.2007.
2. Initial resistance to 500 fpm airflow shall not exceed 0.28" W.C. for a 2" and 4" filters.
3. The filter shall be classified by Underwriters Laboratories as UL Class 2.
4. Manufacturer shall provide evidence of facility certification to ISO 9001:2000 or higher.

C Filters shall be held in galvanized steel holding frames. Filter frames shall be a minimum of 16 gauge G-90 galvanized steel.**2.06 DESICCANT DEHUMIDIFICATION SYSTEM****A Desiccant Rotor**

1. The desiccant shall be made "in-the-flute" encapsulating the fiberglass substrate.
2. The rotor shall be both washable and non-shedding. Rotors shall be capable of withstanding cleaning by vacuum cleaner, with a water or, water and detergent wash.
3. The substrate shall be manufactured with a fiberglass matrix meeting the International Agency for Research on Cancer (IARC) standards for non-respirable fibers.
4. The fiberglass substrate shall provide the structural support for the desiccant. The fiberglass substrate shall be combined with desiccant to form the dehumidifier rotor. The desiccant shall be self-bonding to the fiberglass substrate and to itself through the substrate voids filling in all the voids in the substrate and shall totally encapsulate the fiberglass.
5. The desiccant dehumidification rotor shall be assembled from smooth and corrugated sheets of fiberglass substrate interleaved in a winding to form the rotor creating axial passages through which the air flows
6. Rotor surfaces shall be ground, polished smooth and coated for long seal life.
7. Rated lifetime shall not be less than (87,600) hours and shall be defined by media performance meeting >90% of original specification.
8. Desiccant media shall have a Smoke Developed Index of 0 and a Flame Spread Index of 0 as tested according to ASTM E84.

B Desiccant Rotor – Cassette Frame

1. DH rotor cassette frames and face panels shall be 304 stainless steel. Structural welds shall be continuous. Non-structural stitch-welds shall be on 4" centers.

C Desiccant Rotor – Drive System

1. DH Rotor Drives shall be equipped with hardened carbon steel ANSI drive sprocket, nickel plated corrosion resistant drive chain and spring type automatic chain tension device. Reinforced Elastomeric or plastic rotor drive belts shall not be acceptable.
2. For ease of maintenance and chain alignment, the gear-motor shall be fastened to a 304 stainless steel gear-motor plate.
3. The drive assembly shall be equipped with a magnetic rotation detection device.

D Desiccant Rotor – Seals

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1. Seals shall be FKM fluoropolymer rated for lifetime use (87,600 hours) and rated for 400°F+ continuous temperature rating. Bulb type seals shall not be acceptable.
 2. PTFE tape with an operating temperature range from -100°F to 500°F shall be used as a complementary interface to the FKM seal.
 3. Rotor sector-seals shall seal between the process and reactivation airstreams. Removable hardware shall fasten the sector-seals flanges to the cassette frame partitions. "Pop rivets" shall not be acceptable.
 4. Closures shall utilize high-temperature RTV silicone.
- E Reactivation – Direct Fired Burner
1. The reactivation heat source shall be full-modulation direct-fired (Propane) (Natural) gas. The capacity of the burner shall be sufficient to provide scheduled performance at design cool-day conditions of 50° FDB.
 2. The gas burner shall be fully modulating, with turn-down ratio of 20:1. The gas burner shall have stainless steel baffles and non-clogging gas orifices. The burner assembly and complete pre-piped manifold shall include main and pilot gas regulators, redundant main solenoid shut off valves, electronic modulating rate control valve, pilot solenoid valve, Gas hand-valves and adjustable burner air flow profile plates. Butterfly type modulating gas valves are not acceptable.
 3. Gas trains shall meet or exceed UL 795.
 4. Pilot Burner flame safeguard control system shall be industrial burner programmer with intermittent pilot, pre-purge system and flame rectification proving system.
 5. The gas burner shall be rated at no more than 390 MBH per foot of burner length, in order to limit flame length, and minimize the generation of carbon monoxide.
 6. The control safety devices shall include: air flow proving device, high temperature limit switch, electronic primary flame safeguard with flame rod rectification, microprocessor rate controller, reactivation fan motor starter interlock and seven second combustion chamber pre-purge. Complete assemblies shall be pre-piped, wired, and tested.
 7. Single point reactivation leaving air temperature controls are not acceptable.
 8. The direct-fired burner shall have capacities as indicated on the schedule.
- F Reactivation – Outlet Tunnel
1. The outlet tunnel casing shall be double-wall insulated constructed of 16 gauge interior panels, exterior panels, interior tunnel flooring and 16 gauge interior liners. The interior tunnel flooring shall incorporate a double sloped drain pan with drain. All joints shall be caulked airtight with silicone sealant. The interior panels, liner and tunnel flooring material shall be 304 stainless steel.
 2. The outlet tunnel casing shall be insulated with 3.0# per sq. ft. rigid, rot-proof, non-combustible glass fiber insulation.
 3. The fiberglass insulation shall conform to smoke and flame indices 25/50 (per ASTM E84 and UL 723 and CAN/ULC S102-M88). Meets NFPA 90A and 90B.
 4. All joints shall be caulked airtight with silicone sealant.

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5. The outlet tunnel drain pan shall have a fabricated drainage connection protruding through the floor for the purpose of condensation drainage to the unit exterior.
 6. Closures around all interior components shall be airtight.
 7. Reactivation outlet hood and bird screen are to be made of punched 16 gauge 304 stainless steel.
 8. Where scheduled, reactivation outlet sound attenuator shall be included. The attenuator shall be lined to protect from the high moisture air stream of reactivation.
- G Reactivation – Fan and Motor
1. Reactivation air fan shall be single width, single inlet, direct drive, and fabricated of aluminum to minimize the potential for corrosion.
 2. Fan inlet cone shall be of aluminum construction.
 3. Motors shall be TEFC, NEMA premium efficiency, at the scheduled voltage, 3 phase, 60 Hertz
 4. Motor horsepower shall be as indicated on the schedule.
 5. Fan and motor shall be dynamically balanced as an assembly to 0.15 IPS per AMCA 204-05, balance class BV-3.
- H Reactivation – Outlet Damper
1. Outlet system balancing damper shall be single damper blade 304 stainless steel and include a locking quadrant.
- I Microprocessor Reactivation Rate Controller (RRC) (Internal to unit DDC)
1. The microprocessor controller shall control the unit's reactivation rate, and safeguard functions.
 2. Reactivation energy shall be controlled as follows:
 - a. Desiccant reactivation temperature shall be maintained at optimum temperature for maximum dehumidification performance irrespective of outdoor temperature or filter loading.
 - b. With diminished reactivation airflow (i.e. dirty filters) desiccant reactivation temperature shall be limited to prevent rotor overheat.
 - c. As moisture load decreases, the microprocessor controller shall modulate the heat source as required to limit reactivation outlet temperature. Reactivation rate control that uses a single temperature sensor in the reactivation outlet airstream is NOT acceptable.
 - d. Fail-Safe Mode: In order to preserve limited performance, on gas or electric reactivation units, if the desiccant reactivation inlet or outlet sensor fails, the energy modulation shall be set to 50%.
 - e. To prevent excessive heat on the rotor and seals the unit shall be equipped with a manually reset high temperature limit downstream of the reactivation heat source and upstream of the desiccant rotor. When tripped the reactivation heat source shall cycle off.

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- f. Adequate reactivation energy shall be proven via reactivation outlet temperature. If the reactivation outlet temperature fails to achieve a minimum temperature set-point over a 15 minute period the controller shall signal a low reactivation outlet temperature warning. The unit shall continue to run.
- g. Lack of desiccant rotor rotation shall be detected and shutdown initiated in the event of an abnormal condition.
- h. The reactivation fan shall remain on for two minutes after the reactivation is disabled to allow for cool down of the reactivation tunnel.

2.07 SUPPLY FAN AND MOTOR

- A Direct Drive Wall Mounted Plug Fans
 - 1. Direct drive fan shall be single width, single inlet, airfoil type direct drive wheel.
 - 2. Fan inlet cone shall be of steel construction.
 - 3. Fan and motor shall be dynamically balanced as an assembly to 0.15 IPS per AMCA 204-05, balance class BV-3.
 - 4. Direct drive fan motor shall be isolated from the supply air stream by means of exterior mounting.
 - 5. All fabricated components shall be G90-galvanized steel material.
- B Fan Motors
 - 1. Direct drive fan motors shall be NEMA premium efficient, TEFC.

2.08 VFD CONTROL

- A The unit shall be provided with a VFD for process air volume balancing.
- B Air Volume Rate Capacity Modulation (Optional) - A unit provided with a VFD shall modulate the VFD for volume rate capacity control to accommodate space humidity loads while in the "Unoccupied" ventilation mode.

2.09 ELECTRICAL WIRING

- A All electrical wiring shall be installed in thin wall EMT steel conduit. Use of lengths of flexible conduit will be permitted when EMT conduit is not applicable. Flexible conduit shall be liquid tight, and approved by Underwriter Laboratories
- B Unit panel shall be provided with a terminal strip for ready connection of required external control wiring.
- C A job-specific electrical diagram shall be permanently attached to the electrical enclosure door, contained in a dedicated door-pocket.
- D A job-specific Operation and Installation manual shall reside in the unit electrical enclosure.
- E All work shall conform at the latest National Electric Code.

2.10 CONTROLS

- A The unit control panel shall be supplied with a "dead-front" style disconnect switch for single-point power connection, control transformers, relays, microprocessor controller, circuit breakers, terminal strip and IEC motor starters with overload circuit breaker protection. Fan/Blower motors shall be wired to the motor starters.

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- B Terminal strip connection shall be available for customer's smoke detection, fire protection, E-Stop, or "other fault" inputs to shut down the unit.
- C The DDC controller shall include a built-in user interface. From this display all critical unit functions and alarms may be monitored and adjusted. User interface is to have 6 navigation buttons and shall have a backlight LCD display of 132x64 pixels.
- D Unit Exterior Mounted User Interface
 - 1. A unit mounted user interface shall be provided for troubleshooting and operation monitoring.
 - 2. Shall be mounted on the exterior of the control enclosure so troubleshooting can be done without exposure to high voltage. This interface is to be accessible without opening the control panel door and shall have all the same function capability of the interface on the controller.
 - 3. The user interface shall, at a minimum, include the following:
 - a. Reactivation Energy Rate
 - b. Enable indication of Reactivation values, Process Fan Operation
 - c. Access to view applicable set points and operational modes.
 - d. Ability to diagnose and reset faults
 - e. Alarm history and status' of:
 - 1) Reactivation Flame Failure
 - 2) Desiccant rotor Rotation Fault
 - 3) Process Air Flow
 - 4) Process Fan On
 - 5) Reactivation Air Flow
 - 6) Reactivation Fan On
 - 7) Call for Dehumidification
 - 8) Low Reactivation Temperature
 - 9) Reactivation inlet and outlet temperatures
- E The Unit Exterior Mounted interface shall be IP65 rated and capable of operation at 140F.
- F (Optional) Unit shall include a Remote User Interface. The interface shall be identical in function and format to the controller in the main control panel enclosure. Interface shall be IP65 rated and capable of operation at 140F.
- G (Optional) The controller shall include interface modules for connectivity to BMS systems using BACnet, LonWorks or Modbus protocols.
- H Where scheduled, in addition to mixing box option, unit shall include the following: space mounted CO transmitter, NO2 transmitter and a CO2 transmitter. Remote push button station and control logic shall be included to initiate fixed-duration building contaminant purge mode. (Items shipped loose and installed by electrical trades)
- I Unit shall include a space mounted temperature and dew point transmitter. (Item shipped loose and installed by electrical trades)

2.11 MARKINGS

- A The unit nameplate shall be 0.020" thick Aluminum with permanent fasteners. The nameplate shall be permanently engraved with: Unit model number, serial number, unit Full Load Amps, supply voltage, and filter schedule.
- B The unit shall be permanently marked with the equipment number as identified on the schedule.
- C Warning labels for high voltage and moving parts shall be permanently affixed to access doors and guards.
- D Advisory labels for filter access shall be affixed to applicable doors.
- E Electrical connection, lifting points, air connections, and drains.
- F Indication of correct rotation shall be affixed to all electric motors.
- G An electrical ladder diagram shall be permanently affixed inside of the electrical control panel. The schematic shall be specific to the project and not be a generic type encompassing features or options not present on the unit.

PART 3 EXECUTION**3.01 INSTALLATION**

- A Install packaged desiccant dehumidification units level and plumb.
 - 1. Support floor mounted units on concrete equipment bases. Secure units with anchor bolts if required.
 - 2. Coordinate size of equipment bases with actual unit sizes provided. Construct base 4 inches larger in both directions than the overall dimensions of the supported unit.
 - 3. Support roof mounted units with a curb or structural steel. Secure units with mechanical fasteners.
- B The unit shall be installed in accordance with manufacturer's instructions contained in the Operation and Installation manual.

3.02 START-UP

- A Dehumidification unit shall be started by manufacturer's factory service technician(s) and include training of owner's designated maintenance staff (if available at time of start-up).
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Note any deficiencies with unit installation and/or system deficiencies that could impact the project outcome.

END OF SECTION 23 7425

SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Air-source heat pumps.
- B Air cooled condensing units.
- C Indoor air handling (fan and coil) units for ductless systems.
- D Controls.
- E Equipment Drains and Overflows
- F Equipment Drain insulation
- G Equipment Mounting

1.02 RELATED REQUIREMENTS

- A Section 26 0583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

- A AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2023.
- B AHRI 270 (SI/I-P) - Sound Performance Rating of Outdoor Unitary Equipment; 2025.
- C AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
- D ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
- E ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- F ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- G ASTM B32 - Standard Specification for Solder Metal; 2020.
- H ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- I ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- J ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2026.
- K ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- L ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series); 2025a.
- M ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.
- N 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).
- O NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- P NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.

- Q UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
- D Design Data: Indicate refrigerant pipe sizing.
- E Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
- F Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
- G Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of experience and approved by manufacturer.

1.06 WARRANTY

- A See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B Provide five year manufacturers warranty for compressors.

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A Carrier Corporation: www.carrier.com/#sle.
- B Daikin
- C Mitsubishi
- D Rheem Manufacturing Company Inc: www.rheem.com/#sle.
- E Samsung

2.02 SYSTEM DESIGN

- A Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator.
 - 2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.
- B Performance Requirements: See Drawings for additional requirements.
- C Electrical Characteristics: See Schedule
 - 1. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 26 0583.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

- A Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
1. Location: High-wall.
 2. Cabinet: Plastic.
 - a. Finish: White.
 3. Fan: Line-flow fan direct driven by a single motor.
 4. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
 5. Wall-Mounted Units:
 - a. Heating Output: As scheduled Btuh
 - b. Cooling Output: _____ Btuh As Scheduled Btuh.
- B Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 2. Manufacturer: System manufacturer.

2.04 OUTDOOR UNITS

- A Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
1. Comply with AHRI 210/240.
 2. Refrigerant: R454B R32.
 3. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 4. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.
 5. Sound Rating: 69 dBA, when measured in accordance with AHRI 270 (SI/I-P).
- B Compressor: Variable speed Hermetic, 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high-pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
1. Condenser Fans: Variable speed direct drive.
 2. Condenser Fan Motor: Enclosed, 1-phase type, permanently lubricated.
- D Coil: Air-cooled, aluminum fins bonded to copper tubes.
- E Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.

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2. Provide heat pump reversing valves on heat pump units
- F Operating Controls:
 1. Control by room thermostat to maintain room temperature setting.
 2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to 0 degrees F.
- G Mounting Pad: Pressure preservative treated wood timbers, minimum 4 inches square; minimum of two located under cabinet feet. Mounting pad shall be 4" above finished grade minimum.

2.05 EQUIPMENT DRAINS AND OVERFLOWS

- A Copper Tube: ASTM B88 (ASTM B88M), Type M (C), drawn; using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- B PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
 1. Fittings: ASTM D2466 or D2467, PVC.
 2. Joints: Solvent welded in accordance with ASTM D2855.

2.06 EQUIPMENT DRAIN INSULATION

- A Flexible Elastomeric Insulation
 1. Manufacturers:
 - a. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 2. Armacell LLC; ArmaFlex Ultra with FlameDefense: www.armacell.us/#sle.
 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
 4. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 5. Minimum Service Temperature: Minus 40 degrees F.
 6. Maximum Service Temperature: 180 degrees F.
 7. Connection: Waterproof vapor barrier adhesive.
 8. Plenum Rated
- B Provide 3/8" insulation on all equipment drains and overflows above ceilings and routed in concealed shafts and spaces.

2.07 EQUIPMENT MOUNTING (GROUND)

- A Provide 4" reinforced concrete pad which is a minimum of 6" larger in each direction. Pad shall be minimum of 3" above surrounding grade.
- B Provide 18" heat pump stand on top of concrete pad for all heat pump style units.
- C Pad shall be located a minimum of 18" away from exterior wall and space shall be filled with gravel or space shall be filled with concrete.

2.08 EQUIPMENT MOUNTING (WALL AND ROOF)

- A Manufacturers
 1. DiversiTech

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- 2. Approved Equal
- B Roof Mounted Units
 - 1. Materials of Construction
 - a. Powder Coated Steel
 - b. Hurrican/Seismic Code Compliant
 - c. Applications
 - 1) Single Fan Units
 - 2) Dual Fan Units
 - 3) Multi Unit Capability
 - 2. Provide complete manufactured assembly for roof or wall mouting of condensing units.
 - a. Minimum Height off Roof: 12"
 - b. Minimum Foot Size: 12x12 with Vibration/Protection pad between foot and roof membrane.
 - c. Vibration Isolation: High Density elastomeric-coated pre compressed fiberglass strips which are UV resistant.
 - 3. Provide complete manufactured assembly for roof or wall mouting of condensing units.
 - a. Minimum Height off Roof: 12"
 - b. Minimum Foot Size: 12x12 with Vibration/Protection pad between foot and roof membrane.
 - c. Vibration Isolation: High Density elastomeric-coated pre compressed fiberglass strips which are UV resistant.
 - d. Provide Pitched Roof Bracket when necessary for 9-45 degrees.
 - e. High Wind Resistant to 100 M
- C Wall Mounted Units
 - 1. Materials of Construction
 - a. Aluminum Construction for al Units up to 150 lbs
 - b. Powder Coated or Galvanized Steel for all units over 150 lbs.
 - c. Hurrican/Seismic Code Compliant
 - d. Applications
 - 1) Single Fan Units
 - 2) Dual Fan Units

PART 3 EXECUTION

3.01 EXAMINATION

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

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3.02 INSTALLATION

A Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION 23 8126.13

**SECTION 23 8200
CONVECTION HEATING AND COOLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A Hydronic or steam unit heaters.
- B Hydronic or steam cabinet unit heaters.
- C Fan-coil units.

1.02 RELATED REQUIREMENTS

- A Section 23 0513 - Common Motor Requirements for HVAC Equipment.

1.03 REFERENCE STANDARDS

- A AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001, with Addenda (2011).
- B UL 674 - Electrical Motors and Generators for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A See Section 01 3000 - Administrative Requirements for submittal procedures.
- B Product Data: Provide typical catalog of information including arrangements.
- C Shop Drawings:
 - 1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
- D Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
- E Manufacturer's Instructions: Indicate installation instructions and recommendations.
- F Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- G Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- H Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

- A Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
- B Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 WARRANTY

- A See Section 01 7800 - Closeout Submittals for additional warranty requirements.
- B Provide 1 year manufacturer's warranty for Entire Unit.

PART 2 PRODUCTS**2.01 HYDRONIC UNIT HEATERS**

- A Manufacturers:
 - 1. Modine Manufacturing Company: www.modineHVAC.com/#sle.
 - 2. Sterling Hydronics, a Mestek Company: www.sterlingheat.com/#sle.
 - 3. Daikin Americas
 - 4. Reznor
 - 5. Modine
 - 6. Vulcan
- B Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C Perform factory run test under normal operating conditions, water, and steam flow rates.
- D Casing: Minimum 18 gauge, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods for horizontal models and minimum 18 gauge, 0.0478 inch thick sheet steel top and bottom plates for vertical projection models.
- E Finish: Factory applied baked enamel of manufacturers standard color.
- F Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- G Air Outlet: Adjustable pattern diffuser on vertical projection models and two- way louvers on horizontal projection models.
- H Totally Enclosed Motors: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. See Section 23 0513
- I Control: Local disconnect switch with thermostat.
- J Electrical Characteristics: See Drawing Schedule

2.02 HYDRONIC CABINET UNIT HEATERS

- A Manufacturers:
 - 1. Modine Manufacturing Company: www.modineHVAC.com/#sle.
 - 2. Sterling Hydronics a Mestek Company: www.sterlingheat.com/#sle.
 - 3. Diakin
 - 4. Sigma
- B Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- C Coils:
 - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
- D Cabinet: Minimum 16 gauge, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- E Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.

- F Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- G Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- H Control: Factory wired, solid state, infinite speed control, located in cabinet.
- I Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
- J Electrical Characteristics: See Drawing Schedules

2.03 HOSE KITS AND VALVES

- A Manufacturers:
 - 1. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 - 3. IMI Flow Design, a brand of IMI Hydronic Engineering Division of IMI PLC; _____: www.flowdesign.com/#sle.
 - 4. Pro Hydronics
- B Hoses:
 - 1. Provide hoses for all units for connection to main water supply and return headers.
 - 2. Length: 2 feet.
 - 3. Material: Braided stainless steel rated to minimum 400 psi at 265 degrees F.
- C Manual Balancing Valves:
 - 1. Brass body for shutoff and hydronic balancing.
 - 2. Manufacturers:
- D Ball Valves:
 - 1. Brass body for shutoff and hydronic balancing.
 - 2. Provide memory, memory stop, and pressure/temperature ports.
- E Y Strainers:
 - 1. Bronze body.
 - 2. "Y" type configuration with brass cap.
 - 3. Maximum Operating Pressure: Minimum 450 psi.
 - 4. Screen: Stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

3.03 INSTALLATION

- A Install in accordance with manufacturer's recommendations.
- B Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C Do not damage equipment or finishes.
- D Baseboard Radiation:

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1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
 2. Center elements under window with elements of equal length centered under each window for multiple windows.
 3. Install end caps where units butt against walls.
- E Finned Tube Radiation:
1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
 2. Center elements under window with elements of equal length centered under each window for multiple windows.
 3. Align cabinet joints with window mullions.
 4. Install wall angles where units butt against walls and align cabinet joints with window mullions.
- F Unit Heaters:
1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
- G Cabinet Unit Heaters:
1. Install as indicated.
 2. Coordinate to ensure correct recess size for recessed units.

3.04 FIELD QUALITY CONTROL

- A See Section 01 4000 - Quality Requirements for additional requirements.

3.05 CLEANING

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

3.06 PROTECTION

- A Provide finished cabinet units with protective covers during the balance of construction.

3.07 EQUIPMENT SCHEDULES: SEE DRAWINGS

END OF SECTION 23 8200

**SECTION 26 0500
COMMON WORK RESULTS FOR ELECTRICAL****PART 1 – GENERAL****1.1 DESCRIPTION****A. Specification Format**

1. These Specifications are written in imperative and abbreviated form. This imperative language of the technical sections is directed at the Contractors, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall", "the Contractor shall", and "shall be", and similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, perform all indicated requirements whether stated imperatively or otherwise.
2. Three Part Format
 - a. "Part 1.0 - General": Covers those areas which relate to the Work, and which define the general administrative and technical requirements specific to a particular section.
 - b. "Part 2.0 - Products": Defines, in detail, the acceptance equipment and materials to be incorporated into the Work.
 - c. "Part 3.0 - Execution": Describes, in detail, the manner in which items covered by Part 2 are to be incorporated into the Work.
3. Where Codes, Specifications and Drawings are in conflict, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies immediately to the Engineer prior to commencing related work.

B. Definitions

1. "Furnish" - Supply equipment as required by these Drawings and Specifications, delivered to the job site for installation or use by others.
2. "Install" - Fix in position for total operational use all apparatus as shown, specified or required. Provide all miscellaneous fittings and wiring supplies.
3. "Or Approved Equal" - Equipment or materials selected by Contractor subject to Engineer's acceptance.
4. "Or Equivalent" - Equipment or materials selected by Contractor matching the function and performance of equipment or materials listed.
5. "Provide" - Furnish and install in place, total and operational.
6. "Manufacturer's Representative" – person properly trained/certified for the specific equipment and a regular employee of the Manufacturer, the Manufacturer's Representative Agency, a third party specializing company, or the selling distributor.
7. "Substantial Completion" - The date when the project has been completed, inspected, and accepted by the Engineer and Owner.

C. Work Included

1. Provide labor, equipment and materials in connection with Work specified and shown on Drawings.
2. Work of this Division is subject to requirements of Instructions to Bidders, General Conditions, Supplementary Conditions, Division One, and all other sections of this Specification.
3. Examine site and all Contract documents prior to submittal of bid.

D. Work Installed But Furnished Under Other Directives

1. Provide service for electrically operated equipment not specified in Division 26, 27 & 28. Verify size and locations of such connections by securing all rough-in requirements from the equipment supplier.
2. Equipment requiring electrical service shall be furnished with motors, special controls and remote electrical devices as specified in other Divisions.
3. Verify extent of controls and devices furnished by referring to Divisions where Work is specified.
4. Provide disconnects, starters, control devices, thermal units, fuses, switches and all necessary power and control wiring. Include the installation of remote electrical devices furnished separately with the equipment. Provide identification for remote devices as directed by the Engineer.
5. Contractors of other Divisions providing electrically operated equipment shall verify with the Electrical Contractor the proper voltage and phase before releasing equipment for shipment.
6. Unless otherwise specified, Contractor responsible for furnishing such equipment is also responsible for setting in place.

1.2 ALTERNATES**A. General**

1. The work of this Section is affected by the Alternates described in this Specification.

B. Alternate E-1: Indoor Playground

1. Base Bid: Includes all work without the building addition as shown on Drawings.
2. Alternate: State the Contract Sum to provide the Electrical installation for the Indoor Playground addition as shown on Sheet E302.

C. Alternate E-2: Athletic Training

1. Base Bid: Includes all work without the building addition as shown on Drawings.
2. Alternate: State the Contract Sum to provide the Electrical installation for the Athletic Training addition as shown on Sheet E303.

D. Alternate E-4: SW Parking Lot

1. Base Bid: No work in SW parking lot area which will be grass turf as shown on Drawings.
2. Alternate: State the Contract Sum to provide the Electrical installation for the additional parking lot light poles as shown on Electrical Site plan.

E. Alternate E-5: SE Sidewalk

1. Base Bid: No work for the area which will be grass turf as shown on Drawings.
2. Alternate: State the Contract Sum to provide the Electrical installation for the additional sidewalk light poles as shown on Electrical Site plan.

F. Alternate E-9: Storage 220

1. Base Bid: No work for the area as noted on Drawings.
2. Alternate: State the Contract Sum to provide the Electrical installation for the Storage #220 as shown on the Drawings.

1.3 CONTINGENCY

- A. Use contingency only on issuance of Change Orders.
- B. Refer to Division 1 for the amount to include in the Electrical Bid.
- C. Money remaining in contingency at close of project will be credited to the Owner by Change Order.

1.4 SUBMITTALS

- A. Substitution and Prior Approval to Quote.
 - 1. The reference to manufacturer's name and catalog or model numbers shall be interpreted as establishing a standard of quality, not as limiting competition.
 - 2. Suppliers wishing to price material or equipment not referenced in Specifications or on Drawings shall apply in writing to Engineer for approval to quote. Electronic submittals shall be in PDF format. Include complete descriptive technical data on the proposed item consisting of: model numbers, type, size and performance characteristics. Procedure also applies to requests by Contractor. Self-addressed, stamped envelope required for return reply.
 - 3. The request for prior approval to quote shall be received in Engineer's office no later than 192 hours (eight days) prior to bid opening. All substitute items approved for quotation will be listed in Addenda sent to all planholders in advance of bid opening.
 - 4. Contractors choosing to use material or equipment other than those shown on Drawings or specified in detail, but approved for quotation, shall be responsible for physical dimensions and coordination. Architect, Engineer, or Owner will not be responsible for costs of necessary changes and additional work required by Contractor or any other trades.
 - 5. Substitutions will not be permitted after bid opening.
- B. Correspondence
 - 1. Direct all correspondence concerning Division 26, 27, & 28 submittals to:

JERRY PETERSON
PRAIRIE ENGINEERING, P.C.
1905 17TH ST SE
MINOT, ND 58701
jpeterson@prairieengineeringpc.com
- C. Shop Drawings
 - 1. Before any of the materials are delivered to the job, submit to Engineer via the Prime Contractor complete Shop Drawings for each item indicated.
 - 2. Include catalog numbers, performance data, dimensions and other descriptive information.
 - a. The actual part numbers and options for equipment to be utilized shall be highlighted to indicate exact equipment to be furnished.
 - b. Only include information relevant to the equipment being provided. Any extraneous materials shall be removed prior to submittal.
 - 3. Shop Drawings shall be in electronic PDF format and shall include catalog sheets showing all necessary information. Shop drawings shall be separated by specification section, and equipment from separate specification sections shall not be combined.
 - 4. Shop Drawings shall be submitted under the appropriate specification section of the electronic submittal service being used. The shop drawing file for each section shall include the specification section number, section name, and revision number. Example: "262726 Wiring Devices REV 01".

- a. If an electronic submittal service is not being used, shop drawings may be emailed to the Engineer at the email address indicated above. Emailed shop drawings shall not exceed 10 MB. If shop drawings exceed 10 MB, contact the Engineer to arrange for a file transmittal method.
5. Each Shop Drawing folder shall be **stamped, initialed, and dated**, on a cover sheet included in the PDF submittal by Division 26 Contractor to indicate they have thoroughly reviewed them in accordance with General Conditions. **Email message text not acceptable.**
 - a. If the Division 26 contractor is under a Prime Contractor, the Prime Contractor may also include a review stamp. However this does not relieve the Division 26 contractor from applying their review stamp.
6. Shop Drawings not in conformance with Specification will be returned to Prime Contractor without review.
7. A maximum of two reviews will be completed for each section. Additional submittals required due to lack of proper corrections being made may be subjected to review fees from the Engineer billed to the Division 26 contractor.

D. As-Built Drawings

1. Designate one set of clean blueprints at project site as As-Built Drawings. Make As-Built Drawings available to Engineer during project visitation.
2. As work progresses, Contractor's field supervisor shall mark As-Built Drawings in red pencil to indicate actual conditions of installation.
3. Show same general details as Drawings.
4. Give particular attention to marking actual locations of feeders and underground runs.
5. Affix all addendum and change order descriptions to appropriate as-built drawing sheet, utilizing spray adhesive.
6. Submit As-Built Drawings to Engineer along with Record Manuals at close of project in PDF format.
 - a. As-Built Drawings shall be submitted as one PDF file.
 - b. Record Manuals shall be submitted as one PDF file.
7. Provide minimum one hard copy of As-Built Drawings to the Owner.
8. Review Division 1 for additional requirements for hard copies of As-Built Drawings.

E. Record Manuals

1. Upon completion of Work of this Division and as condition of its acceptance, Contractor shall compile Record Manuals.
 - a. List project name, date, Contractor's name, address and telephone number on exterior label of each Record Manual.
 - b. Provide one electric PDF copy to Engineer for review.
 - 1) After electronic PDF copy is reviewed and approved, provide one hard copy of Record Manual to Owner. Include an index sheet indicating each major piece of equipment, supplier and supplier's telephone number. Provide tabbed dividers indicating major groupings of equipment.
 - 2) Review Division 1 for additional requirements for hard copies of Record Manuals.
 - c. Record Manual information shall be included for all equipment/material where Shop Drawings are required. **Also include all installation, operation and maintenance data packaged with any equipment.**
2. Turn over to Owner all spare equipment and devices specified and shown. List quantities on contractor letterhead or invoice, obtain signature of Owner's representative acknowledging receipt, and include with each Record Manual.
3. Include one copy of formal instructional recordings, properly identified as to specification section.
4. Include copy of State Electrical Board Wiring Certificate in each Record Manual.

5. Include service equipment fault current calculation and step-down transformer fault current calculations in record manuals. Utility transformer fault current shall be calculated per Section 260553-3.3. Step-down transformer fault current shall be calculated per Section 262200-1.2. Provide in tabular form, as per the following example:

Transformer	kVA	Sec. Voltage	Phase	Impedance	Fault Current	Date Calculated
Utility	300	480	3	1.06%	34,043 amps	11/15/2016
T-1	150	208	3	3.8%	10,958 amps	11/15/2016

6. Calculate the available fault current (AFC) for the mechanical and electrical equipment listed and provide the information in tabular form, utilizing naming convention on the drawings.
- HVAC Equipment 1HP and larger
 - Refrigeration Equipment
 - Elevator Equipment
 - Industrial Control Panels
 - Electrical Distribution Equipment
 - Branch Panelboards
 - MCC's.

7. Fault Current Table Format Example:

Equipment	Voltage	Phase	AFC at Equip.	Date Calculated
AH-1	480	3	5,289 amps	11/15/2016
CU-1	208	3	2,321 amps	11/15/2016

8. Transformer fault current table and equipment fault current calculation table shall be grouped together in the same tabbed section of the record manuals.

1.5 QUALITY ASSURANCE

A. Qualifications of Installers

- For installation and testing, use only trained licensed and experienced workmen familiar with items required and manufacturer's recommended methods.
- In acceptance or rejection of installed work, no allowance will be made for lack of skill on the part of the workmen.
- To the maximum extent possible, retain the same supervisory personnel throughout the duration of the Work.

B. Licenses, Permits, Codes and Standards

- Materials, workmanship and installation: comply with the latest editions of all applicable codes, local ordinances, industry standards, utility company regulations, insurance carrier requirements and these Specifications.
- Codes and standards shall include, but not necessarily be limited to, the following:
 - Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL)
 - National Electrical Code (NEC)
 - National Fire Protection Association (NFPA)
 - Occupational Safety and Health Act (OSHA)
 - State and local wiring standards
 - Building and fire codes
- The more stringent provisions shall govern where provisions of pertinent codes and standards conflict with these Specifications or Drawings. Where Codes, Specifications or Drawings differ with one another, the Contractor will be deemed to have bid the more expensive method. Refer all such discrepancies to the Engineer immediately.

4. Pertinent codes and standards shall not be cited to furnish less than specifically shown or specified.
5. Obtain and pay all permits, inspections, licenses and other charges pertaining to the Work. Upon completion of the Work, furnish proof of acceptance by proper agency having jurisdiction.

1.6 GUARANTEE AND WARRANTY

- A. Unless otherwise modified by other sections of this specification, contractor shall guarantee materials, workmanship and the proper operation of equipment for a period of one year. Warranty period shall begin at date of substantial completion, or date of specific equipment commissioning, whichever is later. Contractor shall correct all equipment, material and workmanship found to be defective or non-conforming to the contract documents without cost to Owner.
- B. Guarantee shall include trips to the project site by Contractor to adjust electrical equipment as required, ensuring it is operating as intended.
- C. Specified guarantee shall not relieve Contractor from liability arising from improper installation or non-compliance with applicable codes.
- D. Contractor shall include written warranty statement, indicating start and end dates of warranty period. Warranty statement shall be included with each copy of the Record Manuals.

1.7 CHANGES TO CONTRACT

- A. Any required changes to the contract after bid date shall be in accordance with General Conditions/Division 1 and this section. Where any discrepancies between the sections are encountered, the more restrictive section shall apply.
- B. Proposed changes shall be accompanied with complete substantiating documentation.
 1. Provide an itemized list of quantities for materials, equipment, and supplies.
 - a. Include unit costs for each item and extended price.
 - b. Include unit labor for each item and extended time.
 2. Provide subcontractor proposals that include the same substantiating documentation.
 3. Provide quotations from suppliers for any specially ordered equipment.
- C. Material costs shall be actual costs to the contractor, obtaining the materials through normal supply channels, including trade and quantity discounts. Utilizing "suggested pricing" from national pricing organizations for unit costs shall not be accepted. Upon request, the contractor or subcontractor shall submit evidence to substantiate the costs.
- D. Labor units shall be industry accepted standard labor hours to perform one unit of work. If the work is being performed in a location that is not considered to be standard working conditions for that specific task, additional labor shall be itemized.
- E. Labor rates shall be the actual rate paid for the workman category along with associated labor burden. Labor burden shall consist only of the mandatory fringe benefits, labor taxes, and labor insurances as affected by payroll. The owner reserves the right to reject any labor burden which is inconsistent with other similar contractors or where the fringe benefit cost is in excess of established labor agreements.
- F. Allowable markups for contractor and subcontractors
 1. Overhead on work performed by own forces: 12% maximum.
 2. Profit on work performed by own forces: 10% maximum.
 3. Commission on work performed by Subcontractors: 5% maximum.
 4. Sales tax.

- 5. Bond and permit increases where applicable.
- G. No additional markups shall be allowed for:
 - 1. Field and/or office supervision/administration time.
 - 2. Tool burden.
 - 3. Shop burden.
 - 4. Overhead/Profit applied to work performed by others.
- H. Additional costs for travel and subsistence shall only be allowed if the proposal includes a request for extension of the completion date. Furthermore, those costs shall be proportional to the number of working days of the extension.
- I. Subcontractors shall compute their costs in the same manner as the contractor. Subcontractors are subject to the same markup constraints as described herein.
- J. For changes resulting in credit to the costs, no restocking fees for materials shall be applied by the contractor or subcontractors.

1.8 TEMPORARY FACILITIES

- A. Refer to Special Conditions and/or Division 1 for details of temporary facilities.

1.9 APPLICATIONS FOR PAYMENT

- A. Refer to Division 1 "Applications for Payment".
- B. Provide one additional copy, sent directly to the Engineer.
- C. Format and content:
 - 1. When included with the Bid, the following categories shall be indicated on the application for payment:
 - a. *Project mobilization.*
 - b. *Demolition.*
 - c. *Service & Distribution* (all switchgear, panels, transformers, motor control centers, and loose control/disconnects, installed in place).
 - d. *Lighting* (all fixtures and lamps, installed in place, including pre-fabricated wiring system).
 - e. *Wiring Devices* (all switches, receptacles, and plates, except voice-data, installed in place).
 - f. *Equipment Connections* (HVAC, elevator, food service, etc, connected in place).
 - g. *Basic Materials* (all conduit, wire, boxes, supports, fittings, grounding materials, except special systems and voice-data cabling systems, installed in place).
 - h. *Fire Alarm & Detection* (all system equipment, installed in place).
 - i. *Special Systems* (all system equipment and cabling, installed in place, broken out by Specification Section. Examples include Clock and Program, Intercom, Nurse Call, Public Address, Sound Reinforcement, Rescue Assistance, TV Signal Cabling, Architectural and Theatrical Lighting Controls, and the like).
 - j. *Generator* (all system equipment, installed in place).
 - k. *Voice-Data Cabling Systems* (all system equipment, installed in place).

PART 2 – PRODUCTS

2.1 MATERIAL

- A. Material and equipment shall be as shown or specified. Provide material not specifically described but required for a complete and proper installation of the Work, subject to the acceptance of the Engineer.

- B. All material and equipment shall be new when delivered to the job and be listed by a Nationally Recognized Testing Laboratory (NRTL).
- C. Owner will not be liable for material installed in non-compliance with codes, standards, and these Contract Documents.

2.2 PRODUCT HANDLING

- A. Protection
 - 1. Use all means necessary to protect the materials of this Division before, during and after installation and to protect the installed work and materials of all other trades.
- B. Replacements
 - 1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the Engineer and at no additional cost to the Owner.

PART 3 – EXECUTION

3.1 GENERAL

- A. Engineer, Architect, or Owner shall not be responsible for the means, methods, techniques, sequences or procedures of construction selected by Contractor.
- B. Engineer, Architect, or Owner shall not be responsible for safety precautions and programs incidental to work of Contractor.
- C. It is the sole responsibility of Contractor to initiate, maintain, and supervise all safety precautions and programs in connection with the Work.

3.2 SURFACE CONDITIONS

- A. Prior to work of each Section of Division 26, 27, & 28, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that work of this Division may be installed in accordance with all pertinent codes, regulations and standards.

3.3 COORDINATION

- A. Order material in a timely fashion to assure it is on the job site when required.
- B. Coordinate installation of material with schedule of other trades to prevent unnecessary delay in construction schedule.

3.4 DISCREPANCIES, CONSTRUCTION CONFLICTS AND DRAWINGS

- A. Discrepancies
 - 1. Prior to submitting bid, Contractor shall refer any apparent discrepancies or omissions to Engineer for clarification.
 - 2. The Architect, Engineer or Owner will not be responsible for any oral instructions or modifications to the contract documents prior to opening of bids.

3. Written interpretation or clarification will be made by Addenda.

B. Construction Conflicts

1. Conflicts discovered during construction shall be immediately called to the attention of the Engineer for decision.
2. Do not proceed with installation in area of question until conflict has been fully resolved.
3. When so directed by Engineer, Contractor shall make minor adjustment to avoid interferences with other trades. Such minor adjustments shall be performed at no additional cost to the Architect, Engineer or Owner.

C. Drawings

1. Drawings indicate extent and general layout of electrical systems for project. Due to small scale, it is not possible to indicate all fittings and accessories that may be required. Provide such fittings and accessories as required to form a complete and operating system in general conformance with Specifications and Drawings.
2. Data indicated on Drawings and in these Specifications is as exact as could be secured, but absolute accuracy is not guaranteed.
3. Exact locations, distances, levels and other conditions will be governed by the structure. Field measurements shall take precedence over the Drawings. Use the Drawings and these Specifications for guidance. Secure the Architect's approval for all changes in locations.
4. Verify all measurements at site. No compensation will be made because of difference between locations shown on the Drawings and measurements at the building.
5. Refer to the architectural drawings for dimensions and locations of walls, partitions, doors, windows, ceiling heights, door swings and other details of construction.

3.5 UNDERGROUND UTILITIES

- A. Locations of existing underground utilities are based on available site information and are shown approximately. Contractor shall determine exact utility locations before commencing work and shall be responsible for repair of damages resulting from his construction activities.
- B. Trench and backfill for installation of underground conduits to depth shown or required. Remove any accumulated water in excavation by pumping. Shore and brace excavation as required by safety regulations. Provide temporary bridges to maintain normal traffic flow. Excavation and backfill required by electrical installations shall be accomplished in accordance with Earthwork Specifications by this Contractor.

3.6 CUTTING AND PATCHING

- A. Carefully lay out all work in advance to minimize cutting, channeling or drilling.
- B. Where necessary, all such cutting and patching shall be done in a manner approved by Architect.
- C. Restore damaged surfaces to their original condition by skilled mechanics of the trade involved. Contractor at fault shall assume all cost.
- D. Use only rotary type drilling tools to cut concrete.
- E. Do not endanger the stability of the structure. Do not at any time cut or alter work of any other Contractor without Architect's consent.

3.7 TESTS

- A. Perform all tests as required by Engineer during construction and as described in other Sections of these Specifications.
- B. Testing of entire installation shall be completed before final inspection.

3.8 INSTRUCTIONS

- A. After all required approvals of the Work have been obtained; demonstrate the operation and maintenance of all electrical equipment to the Owner's personnel.
- B. Provide written and oral operating and maintenance instructions to Owner's representatives. The oral instructions shall be given before the Owner occupies the buildings. Instructions to include all building's electrical systems and equipment.
- C. Copies of written operating and maintenance instructions shall be included with each Record Manual.
- D. Electrical Contractor shall coordinate with Owner at Owner's convenience, formal instruction time for contractor personnel to instruct Owner's Representatives on all equipment. Provide similar equipment supplier's instructions where specified thus. Formal instruction to occur with each Record Manual, being referenced to and a part of the Manual.
- E. Formal instructions shall be recorded when required by other Sections of this Specification by this Contractor. Format shall be digital media capable of being played on Windows or Mac operating systems, or shall be submitted on a USB storage device.
 - 1. Electronic PDF files for the as-built drawings and record manuals shall also be included on the USB storage device with the formal instructions.

3.9 CLEAN UP

- A. Remove all scrap material left on job during and after installation of Work.
- B. All equipment having finished paint surfaces shall be examined upon completion for scratches and other damage. Touch up all surfaces as required with paint of color to match factory finish.
- C. Perform all cleaning as required by other Sections of Division 26, 27, & 28.

END OF SECTION

**SECTION 26 0505
TEMPORARY FACILITIES & CONTROLS**

PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included

1. Temporary electricity.

1.2 PRODUCT HANDLING

A. Protection

1. Use all means necessary to maintain temporary facilities and controls in proper and safe condition throughout the progress of Work.

B. Replacements

1. In the event of loss or damage, immediately make all repairs and replacements necessary at no additional cost to Owner.

PART 2 – PRODUCTS

2.1 UTILITIES

A. Temporary Facilities

1. General: all costs, including utility company charges, required for the performance of temporary electrical system, shall be paid by Electrical Contractor.
2. Energy charges: Refer to Division 1 for requirements.
3. Temporary Electricity: Electrical Contractor shall:
 - a. Furnish and install all necessary temporary wiring.
 - b. Provide area distribution boxes located so the individual trades may use their own construction type extension cords.
 - c. Provide GFCI protection on all temporary power per NEC.

END OF SECTION

**SECTION 26 0510
REMODELING WORK****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide work in remodeled area as shown on Drawings and Specifications.

B. Existing Conditions

1. Visit existing building before submitting bid and become familiar with all pertinent existing conditions. Make allowance in bid for all pertinent existing conditions. No Change Orders will be issued:
 - a. For Contractor's failure to visit site and acquaint himself with existing conditions.
 - b. For any portion of remodeled work necessary for complete installation of systems shown.
 - c. Due to Contractor's lack of understanding of amount of work or difficulty of work involved.

PART 2 – PRODUCTS**2.1 See following sections of this Specification.****PART 3 – EXECUTION****3.1 GENERAL**

- A. Wiring in existing building shall remain except as noted on Drawings or specified.
- B. Verify existing conditions relative to work involved and make allowances thereto.
- C. Balance additional loads to existing circuitry between phases.
- D. Furnish a revised, typed panel directory on existing panelboards where circuitry is changed.

3.2 CUTTING AND PATCHING

- A. Carefully lay out all work in advance to minimize cutting, channeling or drilling.
- B. Where necessary, all such cutting and patching shall be done in a manner approved by Architect.
- C. Restore damaged surfaces to their original condition by skilled mechanics of the trade involved. Contractor at fault shall assume all costs.
- D. Use only rotary type drilling tools to cut concrete.
- E. Do not endanger the stability of the structure. Do not at any time cut or alter work of any other Contractor without Architect's consent.

3.3 REMOVAL AND/OR REUSE OF EXISTING MATERIALS AND EQUIPMENT

- A. Remove or relocate existing conduits, wires, equipment, devices or fixtures indicated on Drawings or as required.

- B. Remove any existing non-active voice/data cables including trunk cables, and any other special systems cables in the entirety. Verify with Owner prior to removal.
- C. Remove any existing exposed abandoned raceways, including those above accessible ceiling finishes in their entirety. Verify with Owner prior to removal. Where complete conduit removal is not feasible, cut conduit flush with walls and floors, and patch surfaces.
- D. Provide additional code-mandated supports on any remaining (existing prior to project and located within the remodel area) unsupported raceway systems or communications cabling including fiber optic, voice/data and special systems.
- E. Where existing multi-wire lighting and power branch circuits are modified in any way, it is this Contractor's responsibility to provide additional grounded (neutral) conductors as required between the electrical panelboard and existing circuit devices. Circuit breaker tie-handles are not acceptable. In the event that existing raceways are not properly sized to accommodate the required additional conductors, new raceway shall be installed.
- F. Where the reuse of existing conduits, wires, and devices, or fixtures is permissible, verify that wiring is continuous. Existing outlet or junction boxes shall not be rendered inaccessible by structural changes made to the building.
- G. Verify that no devices are cut off from power source unless specifically noted.
- H. Existing equipment which is indicated as being removed and not indicated for reuse shall remain the property of the Owner, stored as directed. Remove and dispose any material the Owner does not wish to retain, except fluorescent lamps and ballasts.
- I. Do not break, dump or otherwise destroy removed fluorescent and HID lamps, due to possible mercury contamination. Removed lamps are to be recycled and converted by an EPA-Licensed company regularly engaged in this business, and offering this service in accordance with all EPA, State, and Local Regulations:

Green Lights Recycling, Inc.
10040 Davenport Street NE
Blaine, MN 55449
(763) 785-0456

Recycle Technologies
4000 Winnetka Ave. N
Minneapolis, MN 55427
(800) 969-5166

Waste Management Lamp Tracker, Inc.
10050 Naples St NE
Blain, MN 55449
(800) 664-1434

or equivalent as selected by the Contractor.

All associated recycling costs shall be included in this Contract. Recycler shall provide Owner with a Certificate of Conversion, indicating Owner's manifested lamps have been properly recycled and converted. Comply with recycler's packing and shipping instructions.

- J. Do not dump or otherwise destroy removed ballasts, due to possible PCB contamination. Removed ballasts are to be destroyed by an EPA Licensed company regularly engaged in this business, and offering this service in accordance with all EPA, State, and Local Regulations:

Green Lights Recycling, Inc.
10040 Davenport Street NE
Blaine, MN 55449
(763) 785-0456

Recycle Technologies
4000 Winnetka Ave. N
Minneapolis, MN 55427
(800) 969-5166

Waste Management Lamp Tracker, Inc.
10050 Naples St NE
Blain, MN 55449
(800) 664-1434

or equivalent as selected by the Contractor

All associated destruction costs shall be included in this Contract. Recycler shall provide Owner with a Certificate of Destruction, indicating Owner's manifested ballasts have been properly destroyed. Comply with packing and shipping instructions.

- K. Assume existing equipment and fixtures shown to be reused are in good working condition and can be installed without any repairs or, if in unusable condition, notify the Architect for decision. Contractor shall be responsible for any damage by his personnel to equipment in removal or handling.
- L. Provide blank plates as required at existing rough-ins not being re-used.
- M. Clean fixtures and other equipment removed and indicated for reuse. Provide new lamps for reused fixtures.

3.4 ASBESTOS

- A. Contractor is assumed to be knowledgeable about Federal, State, and Local requirements with respect to asbestos issues.
- B. Avoid disturbance of any asbestos-containing material (ACM) within the construction area or elsewhere on the site.
- C. Verify with Owner's "Asbestos Survey and Management Plan" the extent (if any) of existing asbestos.

END OF SECTION

**SECTION 26 0519
CONDUCTORS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide a complete system of conductors enclosed in a raceway.

1.2 SUBMITTALS**A. Record Drawings**

1. Maintain accurate record drawings in accordance with Section 260500.

PART 2 – PRODUCTS**2.1 CONDUCTOR****A. Copper**

1. Soft drawn, annealed.
2. Conductivity of not less than 98% pure copper.
3. Insulated for 600 volt service.
4. #10 AWG and smaller: Solid, THWN/THHN.
5. #8 AWG and larger: Stranded, THWN/THHN.
6. Provide USE where required by Code.

B. Aluminum

1. Electrical grade aluminum alloy conductor material.
2. Insulated for 600 volt service.
3. #1/0 AWG and larger: Compact stranded, THWN/THHN or XHHW-2.
4. Provide USE where required by Code.
5. Manufacturer: Alcan Stabiloy Series or equivalent.

C. MC Cable

1. For use as branch circuit raceway and conductors as described elsewhere in this section.
2. For use in concealed areas only. Exposed MC cable not acceptable.
3. MC cable not acceptable for use in areas where it is subject to physical damage.
4. Standards:
 - a. Listed per UL 1569 Standard for Metal-Clad Cables.
 - b. Follows UL standards 44, 83, 1479, 1569 and 1581.
 - c. Meets requirements of Articles 300 and 330 of the National Electric Code.
5. Armor:
 - a. Interlocked aluminum, helically formed around the conductors.
 - b. Classified 1, 2 or 3 hour rated for through-penetration firestop systems. Use appropriate rating based on Architectural Code plan and fire wall plan.
6. Conductors:
 - a. 600 Volt rated.
 - b. Rated for 90 degree C, dry or wet.

- c. THHN/THWN Copper. Solid or stranded as indicated in Part 2.01.A. Aluminum conductors not acceptable.
- d. Copper, green-insulated grounding conductor included in assembly. Grounding conductor shall be sized based on the over-current protective device of the circuit.
- e. Color coding for phase and neutral conductors as per Part 3.01.B.
- 7. Ampacity:
 - a. Ampacity of the cable shall be determined in accordance with Article 310.15 of the National Electric Code. Installation shall not exceed the ratings of the terminations or the cable assembly.
- 8. Entire cable shall be factory assembled.
- 9. Manufacturer: Southwire Mega MC Cable series or equivalent.

D. MC Cable Fittings

- 1. Fitting construction shall be steel. Zinc diecast fittings not acceptable.
- 2. Fittings shall be clamp on or saddle clamp style.
- 3. Thomas&Betts #XC-Series or Appleton #AMC-Series.
- 4. Provide anti-short bushings at all connectors. Bushings shall be Arlington #AS-series or equivalent.

E. MC Cable Supports

- 1. As required by Codes and Specifications.
- 2. Metal 1-hole cable straps only. Staples and cable ties not acceptable.

2.2 VARIABLE FREQUENCY DRIVE (VFD) CABLE

- A. Non-armored, Type TC cable with 85 percent tinned copper braid, 100 percent foil shield, and full size copper drain wire.
- B. XLPE conductor insulation for 600 volt service.
- C. Manufacturer: Belden 29500 series or equivalent.

2.3 SPLICES

- A. #10 AWG and smaller: Scotchlock Y, R or G as manufactured by 3M Company, or equivalent.
- B. #8 AWG and larger: Compression type, as manufactured by Anderson, Burndy, Thomas and Betts Company, or equivalent.

2.4 LUBRICANT

A. General

- 1. NRTL-listed.
- 2. Flame resistant
- 3. Compatible with conductor insulation.

B. Acceptable Manufacturer

- 1. As selected by Contractor.

PART 3 – EXECUTION**3.1 INSTALLATION****A. General**

1. Install in accordance with Code, product listing, and manufacturer's recommendations.
2. Install wire and cable in Code-conforming raceways after moisture and debris is swabbed from conduit.
3. Refer to system specified for conductor's peculiar to that system.
4. Conductor sizes: Standard AWG, #12 minimum unless otherwise indicated.
5. Fixture taps: minimum #16 AWG.
6. Conductor temperature ratings: Compatible with the equipment to which it is to be connected. Refer to product listing.
7. Make conductor length for parallel feeders identical.
8. Derate ampacities as required for high ambient temperatures or conductor fill.

B. Color

1. Multi-wire (shared neutral) circuits.
 - a. 120/208 volt
 - 1) Phase conductors: Black, red or blue.
 - 2) Grounded conductor (neutral): White.
 - 3) Grounding conductor: Green or bare.
 - b. 277/480 volt
 - 1) Phase conductors: Brown, orange or yellow
 - 2) Grounded conductor (neutral): Gray
 - 3) Grounding conductor: Green or bare.
2. Separate neutral circuits:
 - a. 120/208 volt
 - 1) Phase conductors: Black, red or blue.
 - 2) Grounded conductor (neutral): White with stripe colored to match phase.
 - 3) Grounding conductor: Green or bare
 - b. 277/480 volt
 - 1) Phase conductors: Brown, orange or yellow.
 - 2) Grounded conductor (neutral): Gray with stripe colored to match phase.
 - 3) Grounding conductor: Green or bare
3. Switch legs: Same as phase conductors.
4. 120 volt isolated ground circuits:
 - a. Phase conductor: Orange.
 - b. Grounded conductor (neutral): White with orange stripe.
 - c. Grounding conductor: Green with yellow stripe.

C. Splices

1. Eliminate wherever possible.
2. Made only at outlet or junction boxes.
3. Obtain special permission from Engineer for any splices in feeder conductors.

D. Voltage Drop

1. Increase size of circuit wiring in accordance with NEC 210.19(A)(1), fine print note, No. 4.
2. Use #10 AWG minimum for all home run conductors longer than 75 feet on 120/208/240 systems and 150 feet on 277/480 systems.

E. VFD Cable

1. Install cable from load terminals of VFD to motor.
2. Enclose cable in raceway system (conduit and flexible conduit).
3. Terminate the drain wire to the ground lug at both the VFD and the motor.

F. MC Cable

1. General:
 - a. Cable shall be supported at intervals not exceeding six feet. Supports shall be anchored to building structural components. Anchoring to suspended ceiling support cables not acceptable.
 - b. Bends shall be made such that they do not damage cable.
 - c. Radius of the curve of the inner edge of any bend should not be less than seven times the diameter of the cable.
 - d. Maximum sidewall pressure shall not be greater than 500 pounds.
 - e. Use appropriate rotary cutting tool for cutting of armor. No hacksaws, diagonal pliers, tin snips or "breaking" of armor allowed for cutting. Cable shall be replaced where improper cutting methods are employed.
2. Uses Permitted:
 - a. MC cable is acceptable for branch circuitry within single spaces. Circuitry shall enter the space from branch circuit /homerun in raceway as per Section 260533. MC cable may be extended from junction box to luminaires and wiring devices within that space only.
 - b. Where adjacent rooms share the same circuits from the same homerun, extend raceway per Section 260533 to a junction box in each space.
 - c. Cable may extend concealed in walls between wiring devices within the same space.
3. Uses Not Permitted:
 - a. As feeders.
 - b. As branch circuit homeruns.
 - c. In areas where cable is exposed or within view.
 - d. In areas where cable is subject to physical damage.
 - e. In underground or concrete encased locations.

G. Aluminum Conductors

1. Unless otherwise indicated, all references on these Drawings are for copper conductors. At Contractor's option, aluminum conductor sizes #6 AWG and larger may be substituted in service and panel feeder runs provided all of the following conditions are met:
 - a. Conductor and raceway size increased to the same or greater capacity rating.
 - b. Install aluminum conductors in strict accordance with current editions of UL Standard 486A-486B "Wire Connectors", American National Standard NECA/AA 104 "Aluminum Building Wire and Cable", Aluminum Association Publication 51 "Aluminum Building Wire Installation Manual and Design Guide", specific manufacturer's instructions included with equipment, and this specification.
 - c. Terminate aluminum conductors in accordance with referenced Standards, including, but not limited to the following operations:
 - 1) Use listed AL7CU or AL9CU connectors sized to accept aluminum conductors to the ampacity specified.
 - 2) Using a suitable stripping tool to avoid damage to the conductor, remove insulation from the required length of the conductor.
 - 3) Wire brush the conductor and apply a listed joint compound.
 - 4) Tighten the connection per the connector manufacturer's recommendations.
 - 5) Wipe off any excess joint compound.
 - 6) Retighten all connections to recommended torque levels immediately prior to Final Project Visitation.

3.2 TESTS

- A. After equipment and wiring is installed, and before it is energized, test all power circuits with a megohmmeter for insulation resistance, phase-to-phase and phase-to-ground faults.
- B. Before testing, disconnect all equipment that might be damaged by the test voltages.

END OF SECTION

SECTION 26 0526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Bond and ground all electrical equipment in accordance with National Electrical Code, State/Local Codes, these Specifications and as shown on Drawings.

B. Description of System

1. The service equipment, conduit systems, supports, cabinets and neutral conductor shall be solidly grounded and bonded in accordance with National Electrical Code to form a permanent effective and continuous grounded system.

PART 2 – PRODUCTS**2.1 GROUND RODS**

- A. Steel with a metallically bonded outer layer of electrolytically applied copper.
- B. Minimum 1/2" diameter 10 foot length, unless otherwise indicated.
- C. Sectional rods not permitted.
- D. Manufacturer: ERITECH or equivalent.

2.2 GROUND ROD CLAMPS

- A. Ground rod clamps shall be high strength silicone bronze.
- B. Manufacturer: ERITECH or equivalent.
- C. At Contractor's option, exothermic welding (CADWELD) or impact compression (ERITECH Hammerlock) may be used in place of ground rod clamps.

2.3 WATER PIPE GROUND CLAMPS

- A. Steel U-bolt with bronze saddle.
- B. Thomas and Betts Company 3900 series or equivalent.

2.4 REBAR GROUND CLAMPS

- A. Bronze alloy construction.
- B. Sized as required by rebar stub out.
- C. Eritech RC or EK series as required by local authority. Equivalent products by Thomas and Betts acceptable.

PART 3 – EXECUTION**3.1 GENERAL**

- A. **Grounding conductors not shown or included on floor plans.**
- B. **When required, increase trade size of raceway accordingly.**
- C. Aluminum not acceptable for use as a grounding conductor.

3.2 SYSTEM GROUNDING

- A. Provide grounding electrode system in accordance with NEC 250.50. If available, each of the items listed in 250.52(A)(1) through (A)(8) shall be bonded together to form grounding electrode system.
- B. Connect grounding electrode conductor to grounded service conductor.
- C. Provide raceway enclosing grounding electrode conductor. If metallic, bond as per NEC 250.64(E). Provide grounding bushing as required complete with jumpers same size as grounding electrode conductor.
- D. To comply with NEC 250.53, provide two ground rods spaced minimum 6'-0" apart.

3.3 EQUIPMENT GROUNDING CONDUCTOR

- A. Non-metallic conduit: Sized in accordance with NEC, except as further modified by this Specification.
- B. Flexible Metal Conduit, Liquidtight Flexible Conduit.
 - 1. Other than for connection of 120 volt recessed luminaires, not acceptable for use as means of grounding.
 - 2. Provide bonding jumper sized in accordance with NEC around all flexible conduits. Use fittings having lugs for termination of jumper.
 - 3. Spiral wrap not acceptable. Lay along surface, secured with cable ties.
 - 4. Bonding jumper maximum length: 6'.
 - 5. Bonding jumper not required where separate equipment grounding conductor is used.
- C. Branch Circuits
 - 1. **Separate equipment grounding conductor required for each raceway.**
 - 2. Size: per NEC 250.122.
 - 3. Bond to grounding bars, junction boxes and luminaire grounding screws.
 - 4. Field install grounding screw in luminaire if not provided by factory.
- D. Feeders
 - 1. **Separate grounding conductor required.**
 - 2. Bond to grounding bars in switchboards, panelboards and motor control centers.
 - 3. Provide grounding bushing at both ends of all feeders utilizing metallic raceway.
 - a. Bond to grounding bars at both ends.
 - b. Size bonding jumpers to match equipment grounding conductor.
 - 4. Feeder Equipment Grounding Conductor Size:
 - a. Size per NEC 250.122.
 - b. Copper equivalent ampacity when aluminum phase conductors utilized.
 - 5. Do not splice grounding conductor.

E. Water Pipe System

1. Bond interior metal water piping per NEC Section 250.104(A) if water pipe system is not used as part of grounding electrode system.

END OF SECTION

**SECTION 26 0533
RACEWAYS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide all conduit systems as shown on Drawings or required by Codes and Specifications.

B. Description of System.

1. Provide code-conforming raceway system for all conductors unless specifically noted otherwise by phrase "not in conduit".

1.2 SUBMITTALS**A. Record Drawings**

1. Maintain accurate record drawings for all raceway runs in accordance with Section 260500.

PART 2 – PRODUCTS**2.1 MATERIALS****A. Metallic conduit and tubing: Allied Tube and Conduit, Republic Conduit, or equivalent.****B. Non-metallic conduit: Carlon Schedule 40 or Schedule 80 where required, Allied Tube and Conduit, Cantex Inc., or equivalent.****C. Flexible metal conduit: Aluminum.****D. Liquidtight, flexible metal conduit: Anaconda Sealtite or equivalent.****E. Fittings**

1. Rigid metal conduit: Appleton, Crouse-Hinds, or equivalent. **Pot metal conduit fittings not acceptable.**
2. EMT:
 - a. **Steel.**
 - b. Setscrew or watertight as required.
 - c. Thomas and Betts Company, or equivalent.
 - d. **Pot metal, "Sock-on" and indentor fittings not acceptable.**
3. Flexible metal conduit: STEEL, Thomas and Betts Company XC-400 series, or equivalent.
4. Liquidtight flexible metal conduit:
 - a. **Steel.**
 - b. Straight or angled as required.
 - c. Appleton, Thomas and Betts Company or equivalent.

F. Hangers and Supports

1. As required by Codes and Specifications.
2. Raco, Unistrut, or equivalent.
3. Erico conduit clips, Type 8-M, 12-M and K-8 acceptable for individual branch circuit runs.

G. Wireway

1. NRTL 870 listing throughout, including connectors and fittings.
2. Hinged cover construction.
3. Sealing capability where required.
4. Suitable for "lay-in" installation of conductors.
5. Rust inhibiting phosphatizing undercoat and baked enamel finish.
6. Plated hardware.
7. Square D "Square Duct" or equivalent.

H. Expansion Fittings

1. Metallic: OZ, Thomas and Betts Company, or equivalent.
2. Non-Metallic: Carlon, or equivalent.

I. Firestop Assemblies

1. Firestop systems shall consist of fittings and/or intumescent materials assembled as per UL (or other NRTL) System Details.
2. Product manufacturers: 3M, Chase Technology Corporation, Dow Corning Fire Stop, Hilti, International Protective Coatings Corp. (Flame Safe), Nelson Fire Stop Systems.

J. Thru Wall and Floor Seals

1. OZ-Gedney Type "FSK" or equivalent.

PART 3 – EXECUTION**3.1 INSTALLATION**

A. General

1. Electrically continuous throughout.
2. Plumb and level.
3. Cut square and reamed smooth.
4. Use commercial bender for offsets and bends.
5. Cap to prevent debris from entering during construction.
6. Swab conduit prior to installation of conductor.
7. Provide pull cord in empty conduits.
8. Alter conduit routing to avoid structural obstructions, minimizing crossovers.
9. It is the intent of this Specification to provide reasonable provisions for future expansion of electrical use (See NEC 90.8 and 90.1(B), FPN). Combining of home runs is acceptable and Contractor shall increase conduit size accordingly.
10. Install raceway, conduit and fittings in accordance with Code, NRTL listing and manufacturer's recommendations.

B. Concealed Interior Raceway

1. Conceal all raceway within building construction as much as possible.
2. May be run in a direct line for Contractor's convenience.
3. For Contractor's convenience, **concealed** stubs from concrete-encased PVC conduit runs may extend to first **concealed** junction box.
4. Where applicable, center within insulation any electrical conduit routed in attic space. Provide sealing as per NEC 300.7(A) for all conduits exposed to different temperatures.

C. Exposed Interior Raceway

1. Use limited to mechanical and electrical equipment rooms, where exposed structural PEMB members exist, exterior PEMB walls, motor connections, and panelboards scheduled as surface.
 - a. Run parallel or perpendicular to building lines.
 - b. **Provide RGSC or EMT stubs for concrete-encased PVC conduit runs.** Extend stub from RGSC coupling set flush in floor.
 - c. Provide flexible conduit as required for motor and equipment connections.

D. Concrete Encased Raceway

1. Shall not interfere with structural integrity of slab, column, or beam.
2. Installation subject to acceptance of Structural Engineer.
3. Maximum diameter 1/3 thickness of concrete member.
4. Install in center of section.
5. Provide expansion fitting when crossing building expansion joint. Grounding integrity of raceway to be maintained.

E. Exterior Raceway

1. Minimum 24" below grade.
2. PVC unless otherwise indicated.
3. **Exterior surface stubs for PVC conduit runs: RGSC, including final underground sweep.** Exterior surface stubs acceptable only where specifically shown.
4. Penetrating Watertight Walls or Floors: Provide block-out with 1/2" clearance around conduit for underground penetrations. Pack with Oakum and caulk with non-shrinking grout, or provide conduit entrance seal.
5. Penetrating Roof or Waterproofing Membranes: Provide flashing and pitch pocket.
6. Contractor responsible for providing a watertight penetration.
7. Coat RGSC penetrations with heavy asphaltic-base compound.
8. Unless otherwise indicated, route exterior conduits to interior distribution equipment concealed under slab.

F. Supports

1. Refer to NEC 300.11
2. **Tie wire supports not acceptable.**
3. Support Spacing: NEC.

G. Specific Locations

1. Allow 6" minimum clearance at flues, steam pipes and heat sources.
2. Conduit visible behind grills and registers: paint black.
3. Seal conduit where leaving heated area and entering unheated area.
4. Penetrating non-watertight walls or floors: Pack space between conduit and block-out on both sides with Oakum.
5. Penetrating fire rated walls or floors: Seal to prevent passage of fire or products of combustion.
6. From each flush mounted panel location, stub three additional 3/4" conduits into nearest accessible ceiling space.
7. Do not mount raceway on ductwork, cover access doors, panels, controls, or otherwise hinder normal maintenance and repair of the equipment.
8. Motors:
 - a. Connect to motor feeder or branch circuit by means of flexible metal conduit or liquidtight flexible metal conduit in moist areas.
 - b. Minimum flexible length: 18".

- c. Where practical, feed floor mounted motors from raceway installed in or under slab.
- d. When floor mounted motors are fed overhead, provide required support for raceway. Extend raceway to floor and provide a floor flange. Insert "T" conduit fitting at proper height and extend flexible conduit to motor.

H. Specific Systems

- 1. Fire Alarm
 - a. All raceway systems shall be externally identified by permanent RED paint suitable for the purpose to easily distinguish from other electrical raceway systems. Items shall be painted prior to installation. In addition to field painted conduit, factory painted conduit as manufactured by Allied Tube & Conduit or equivalent is acceptable.
- 2. Exceptions: Raceway color coding shall not apply to the following areas:
 - a. Raceway systems embedded directly in earth or concrete.
 - b. Surface mounted raceways systems in finished spaces where all raceways are to be painted to match adjacent surfaces.

3.2 SIZE

A. National Electrical Code, subject to stated minimums.

B. Minimum Size

- 1. Exterior raceway: 3/4".
- 2. In or under poured concrete (including precast concrete panels): 3/4".
- 3. Branch circuit home run: 3/4". Consider home run to include raceway length from panelboard, switchboard, or motor control center to nearest power consuming or switching device on that circuit.
- 4. Feeders: 3/4".
- 5. All others not listed: 1/2".

3.3 TYPE

A. Intermediate Metal Conduit (IMC)

- 1. May be used in place of rigid galvanized steel conduit for Contractor's convenience.
- 2. Comply with manufacturer's recommendations for bending, threading and cutting operations.
- 3. Install as specified for rigid galvanized steel conduit.

B. Rigid Galvanized Steel Conduit (RGSC)

- 1. Use:
 - a. Overhead electric and telephone service entrance. IMC or Aluminum not acceptable for this application.
 - b. All raceway exposed to weather. Aluminum not acceptable for this application.
 - c. Where required by national, state and local codes.
- 2. Fittings: Threaded except at KO type boxes where double locknut/bushing method acceptable.
- 3. Waterproof entire length with heavy asphaltic base compound when:
 - a. Embedded directly in earth.
 - b. Embedded in concrete directly in contact with earth, with or without vapor barrier.
 - c. Penetrations run directly from concrete with earth, to soil burial.
- 4. Factory applied PVC coating acceptable in place of asphaltic base compound.

C. Rigid Non-Metallic Conduit (PVC)

1. Use only in slabs and exterior underground locations. See 3.1 B3, C4 and E3 for limitations.
2. Provide insulating bushing at all terminal adapters.
3. Provide equipment grounding conductor within raceway.
4. Increase trade size accordingly for equipment grounding conductor.
5. Utilize commercial heating element type bending equipment. **Do not use torches to bend PVC conduit.**

D. Electrical Metallic Tubing (EMT)

1. Use in all areas not prohibited by NEC and this Specification.
2. Do not use in concrete slabs on or under grade, or walls under grade.
3. Do not use in exterior underground applications.

E. Flexible Metal Conduit

1. Use for connections to transformers, motors, fixed appliances, recessed luminaires and other equipment as required.
2. Use liquidtight conduit with liquidtight fittings in areas of high moisture content.

F. Fire Resistive Walls and Decks

1. Preserve integrity of fire rating through the use of UL (or other NRTL) Listed firestop assemblies of appropriate penetration type and rating time.
2. Install in accordance with manufacturer's recommendations.
3. All floor to floor penetrations and all wall penetrations into Mechanical, Electrical, and Communications Rooms shall be sealed with 1 hour firestop assemblies unless more stringent rating is required by building codes.
4. Include UL (or other NRTL) firestop assembly sheets and manufacturer product data sheets specifically used with the Project Closeout Documentation.

END OF SECTION

**SECTION 26 0534
OUTLET, PULL AND JUNCTION BOXES****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide all outlet, pull and junction boxes complete with associated covers and rings.

B. Work Installed But Furnished Under Other Directives.

1. Obtain manufacturer's backboxes or recommendations for special equipment.

1.2 SUBMITTALS**A. Record Drawings**

1. Maintain accurate record drawings in accordance with Section 260500.

PART 2 – PRODUCTS**2.1 CEILING BOXES****A. Flush and Surface**

1. 2-1/8" minimum depth.
2. Square or octagon as required.
3. Galvanized steel.
4. Manufacturer: Appleton, Raco, Steel City or equivalent.

2.2 WALL BOXES**A. Flush**

1. One and two gang wall boxes: 4" square box, 2-1/8" minimum depth with appropriate plaster or tile ring.
2. More than three gang: Gangable 3-1/2" deep unless wall cavity limits depth to 2-1/2".
3. Use 4-11/16" square boxes where required by Code.
4. Single gang masonry boxes acceptable only for single conduit entrance. Feed-through circuiting not acceptable. Use 4" square box/tile ring for feed-through applications.

B. Surface Mounted Devices

1. 4" square box, 2-1/8" minimum depth with appropriate 1/2" raised cover.
2. Manufacturer: Appleton, B-Line, Raco, Steel City, Wiegmann, or equivalent.

C. Sectional, through wall and handy boxes not acceptable.**2.3 PULL AND JUNCTION BOXES****A. Galvanized steel with cover.****B. Size: National Electrical Code.**

- C. Manufacturer: Appleton, Raco, Hoffman, Shallbetter, Steel City, Wadsworth or equivalent.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General

1. Install in accordance with code, product listing and manufacturer's recommendations.
2. Install boxes plumb, level and flush with finish surface.
3. Support securely and rigidly.
4. Verify wall depths to ensure adequate clearance for special backboxes.
5. Provide barriers in ganged switch outlets where voltage between adjacent switches exceeds 300 volts.

B. Location

1. Governed by structural conditions and obstructions.
2. Mount switch outlet on strike side of door, maximum 4" from door opening to first switch. Verify door swing with Architectural Plan.
3. Coordinate equipment outlets prior to installation for proper concealment.
4. Center outlets with respect to acoustical tile, paneling and furring trim.
5. Adjust outlets in masonry or tile construction to horizontal and vertical mortar joints.
6. Clear all piping, ductwork and other obstructions.
7. For outlet boxes on opposite sides of walls or partitions with separation distances of 24" or less, pack all interconnecting conduits with Duxseal after conductor installation, to prevent sound transmission.
8. Outlet boxes improperly located shall be corrected at Contractor's expense.

C. Mounting Heights

1. All device mounting heights shall conform to ADA Recommendations. Refer to Standard Electrical Symbol Legend for nominal mounting heights.
2. Verify height of all outlets to ensure installation above top of radiation covers, mirrors, counters and any other obstructions that may alter nominal mounting height.
3. **Measure from finish floor to centerline of outlet.**
4. Mount exterior outlets horizontally. Measure height from nearest interior finish floor below outlet.
5. Mount outlet designated AC (above counter) no less than 4" higher than top of countertop backsplash.

D. Fire Resistive Walls and Ceilings

1. Penetrations for steel electrical outlet boxes permitted, provided:
 - a. Boxes do not exceed 16 square inches in area.
 - b. Area of such openings shall not exceed 100 square inches for any 100 square feet of area.
 - c. Outlet boxes on opposite sides of walls or partitions separated by horizontal distance of 24 inches.

E. Pull and Junction Boxes

1. Pull and junction boxes are generally not indicated on Drawings.
2. Install in accordance with National Electrical Code and as required to facilitate wire pulling.
3. Do not install in finished spaces without approval of Engineer.

F. Identification

1. Identify pull and junction boxes containing system voltages in excess of 250 volts to ground with voltage markers.
2. Voltage markers: Not visible in finished areas.

END OF SECTION

**SECTION 26 0536
CABLE TRAY****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide cable tray systems as shown on Drawings.

B. Description of System.

1. Provide complete cable tray system shown on Drawings and herein specified. System shall be of one manufacturer with all drop-outs, supports, and all other hardware required for a complete, acceptable, and approved system.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Indicate:
 - a. Product dimensions
 - b. Mounting details
 - c. Support hardware

PART 2 – PRODUCTS**2.1 MANUFACTURER**

- A. Sizing and design based upon B-Line equipment. B-Line catalog numbers used for reference.
- B. Other acceptable manufacturers: Cablofil, Snake Tray, Mono-Systems, Inc., WBT, or equivalent.

2.2 BASKET TYPE TRAY

- A. ASTM A510 Grade 1008 steel construction with mesh size no larger than 2" x 4".
- B. All welds and edges smoothed free of burrs and sharp edges.
- C. Zinc plated after fabrication.
- D. 2 inch load depth and 12 inch width.
- E. Include black plastic insert wherever cable tray is visible from the floor (not concealed above ceilings).
- F. Manufacturer: B-Line FT Series.

2.3 MISCELLANEOUS PRODUCTS**A. Firestop Assemblies**

1. NRTL listed 4" square pathway with intumescent material designed to seal out fire, smoke, and toxic gases.

2. Quantity shall equal or exceed the width of the associated cable tray. i.e. a 6" wide tray requires two pathways.
3. Include mounting accessories as required by application specifics.
4. Manufacturer: EZ Path Series 44, 3M Model PT4SD or approved equal.

B. Equipment Grounding Conductors

1. Required when specified for power circuits.
2. Bond in accordance with NEC 250.96 and 250.102.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install in accordance with NEC and manufacturer's instructions.
- B. Install Basket Type Tray where indicated on Drawings.
- C. Coordinate installation to avoid conflicts with light fixtures, duct work, piping, or other mechanical equipment.
 1. Tray does not have to be completely continuous. Section breaks of up to 36" are allowable for ductwork and other mechanical equipment conflicts.
- D. Provide backing for wall-mount track and support for ceiling-mount tray as required.
- E. No exposed hanger rod threads from bracket to a minimum of 6" above top of tray.
- F. Fire Resistive Walls.
 1. End cable tray within 6" of each side fire rated walls.
 2. Install Firestop Assembly through rated wall as per manufacturer's recommendations.
- G. All floor to floor penetrations and all wall penetrations into Mechanical, Electrical, and Communications Rooms.
 1. End cable tray within 6" of each side of penetration.
 2. Install Firestop Assembly through floor or wall as per manufacturer's recommendations.

END OF SECTION

**SECTION 26 0540
FLOOR BOXES****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide floor boxes complete with devices, fittings and carpet flanges.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Show all details, including dimensions and service fitting repair parts.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying equipment.

PART 2 – PRODUCTS**2.1 CONCRETE FLOOR SLABS****A. Type A**

1. Box
 - a. Listed and evaluated by an NRTL to meet the applicable U.S. safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.
 - b. Construction:
 - 1) Stamped steel, 3.75" overall height with 3/4" to 1-1/4" side knockouts and 3/4" to 1-1/2" bottom knockouts.
 - a) Provide optional 2" threaded hub adapter as required.
 - c. Provide epoxy coating where the box is in direct contact with earth.
 - d. Four independent wiring compartments that allow capacity for up to four duplex receptacles and/or communication services.
 - e. Feed through removable barriers from adjacent compartments.
 - f. Internal power and communication device brackets as required by specified internal device types and quantities. Provide internal blank plates for all unused compartments.
 - g. Manufacturer: Wiremold #RFBA4C series.
2. Activation Kit (Cover) – Carpeted Areas
 - a. Die cast aluminum, low profile, round cover with beveled edge flange to sit on top of floor covering.
 - b. Finish as selected by the Architect.
 - 1) Powder coat finish: Black, Bronze, or Gray.
 - 2) Metallic finish: Brushed Aluminum, Satin Brass, or Satin Nickel.
 - c. Manufacturer: Wiremold #6CTC2 series.
3. Activation Kit (Cover) – Tile/Finished Concrete Floors
 - a. Die cast aluminum, low profile, round cover with flange to sit flush with floor covering.
 - b. Include nonmetallic pre-pour trim ring.
 - c. Provide Tile Shim set to adjust cover to floor height.
 - d. Finish as selected by the Architect.

- 1) Powder coat finish: Black, Bronze, or Gray.
- 2) Metallic finish: Brushed Aluminum, Satin Brass, or Satin Nickel.
- e. Manufacturer: Wiremold #6CT2 series.

2.2 DEVICE QUANTITIES

- A. Type A: One duplex receptacle, two data and one voice jacks (two per device opening), one HDMI input.

2.3 WIRING DEVICES

- A. Power: Receptacles as per Section 262726.
- B. Voice/data: Jacks as per Section 271500.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Verify concrete depth prior to ordering floor boxes.
- B. Verify exact location of each floor box with Architect prior to installation.
- C. Install box opening flush with floor in accordance with Code, product listing and manufacturer's recommendations.
- D. Activation Cover Installation
 1. Carpet/VCT floor finishes: Install cover after floor covering installation is completed.
 2. Tile floor finishes: Install cover prior to tile/grout installation. Shim cover as required so top of cover is flush with floor.
- E. Install floor boxes with square covers parallel or perpendicular to building lines.

END OF SECTION

**SECTION 26 0553
IDENTIFICATION****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Label electrical equipment as required by Codes and Specifications and as specifically directed by Engineer.

PART 2 – PRODUCTS**2.1 PANEL DIRECTORIES**

- A. Include directory cards with panelboards.

2.2 NAMEPLATES

- A. Machine engraved black laminate with white core, except as otherwise indicated.
- B. Minimum letter size: 1/8".
- C. Minimum plate size: 1" X 3".

2.3 VOLTAGE MARKERS

- A. Vinyl impregnated cloth markers with legend as required.
- B. Manufacturer: Ideal #44-360, or equivalent.

2.4 PRESSURE SENSITIVE TAPE

- A. Use only when specifically referred to in other Sections.
- B. Manufacturer: Dymo, or equivalent.

2.5 UNGROUNDED CONDUCTOR IDENTIFICATION

- A. As per NEC 210.5(C) and 215.12(C).
- B. Typewritten cards behind plastic shield, affixed with double-stick carpet tape. Heat surface prior to affixing directory.

PART 3 – EXECUTION**3.1 GENERAL****A. Directory Cards**

1. **Typewritten only.** Hand lettering unacceptable, except at "spares" and "spaces", where neat hand lettering with erasable pencil is required.
2. Indicate type of load and rooms where load occurs.
3. **Do not use room numbers as shown on Drawings, but refer to name and numbers on door.**

4. Do not identify until final load balancing is accomplished.

B. Nameplates

1. Apply plumb and level with two counter-sunk screws.
2. Glue, double-stick tape, or similar adhesive not acceptable.

C. Device Plates

1. Machine engrave directly on plate in lieu of separate nameplate.
2. Fill inscriptions with contrasting color.

D. Voltage Markers

1. Not visible in finished areas.

E. Junction Boxes

1. Mark all covers with indelible marker to indicate panelboard designation and circuit numbers for circuits contained within box.

3.2 EMERGENCY SYSTEM COMPONENTS

- A. All boxes and enclosures (including transfer switches, generators and power panels) for emergency circuits shall be permanently marked so they will be identified as a component of an emergency circuit for system.

3.3 SERVICE EQUIPMENT FAULT CURRENT NAMEPLATE

- A. Provide warning nameplate on each service disconnecting means enclosure indicating the fault current of the system.
- B. Fault current shall be calculated at the utility transformer, using an assumed infinite primary bus, and using the actual transformer impedance and kVa values.
- C. Red laminate with white core.
- D. Letter height: minimum 1/4"
- E. Legend

SERVICE AVAILABLE FAULT CURRENT: _____
TRANSFORMER KVA: _____
TRANSFORMER IMPEDANCE: _____
DATE: _____

END OF SECTION

**SECTION 26 0573
POWER SYSTEM STUDY****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide a complete fault current analysis and protective device coordination study in accordance with IEEE 242 for the entire distribution system utilizing computer based modeling. If the project interfaces with existing electrical equipment, utilize the first existing upstream overcurrent device outside the project scope as a fixed reference point.
2. Provide a complete arc flash analysis in accordance with IEEE 1584 requirements. Install specific Arc Flash Protection Boundary and Incident Energy label on all electrical equipment within the study scope in accordance with NFPA 70E.

1.2 QUALIFICATIONS

- A. The analysis and report shall be performed by a professional engineer licensed in the state where the Project is located. The engineer shall be regularly engaged in the practice of short circuit, device coordination, and arc flash studies utilizing computer programs.

1.3 SUBMITTALS**A. Shop Drawings:**

1. Preliminary Fault Current and Coordination reports shall be submitted and approved as a prerequisite to approval of associated electrical distribution equipment shop drawings. The system model shall include:
 - a. Utility Transformer and Metering Equipment
 - b. Power Distribution Equipment
 - c. Motor Control Centers
 - d. Branch Panelboards
 - e. Transformers
 - f. Generators and Transfer Equipment
 - g. UPS systems
 - h. Elevators
 - i. HVAC Equipment 10 HP/30 MCA and larger
 - j. Refrigeration Equipment
 - k. Industrial Control Panels
2. Submit information in accordance with Section 260500. Show all details of:
 - a. General report information including labeling convention and computer program utilized.
 - b. Single-line diagram.
 - c. Equipment input data.
 - d. System impedance diagram utilizing estimated feeder lengths based on anticipated conduit routing.
 - e. Fault current and equipment duty evaluation reports.
 - f. Preliminary device setting reports including time current curves.
 - g. Evaluation results and recommendations if any.
 - h. Sample Arc Flash Label.

3. Final Fault Current and Coordination reports shall be submitted after all final conductor lengths are known. Any settings adjusted based on any changes during construction shall be indicated on final report. Any changes to the drawings during construction that impact the fault current and coordination report shall also be included in the final report.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include final fault current and coordination report, with all corrections and changes included.
3. Include Arc Flash Hazard Report.

PART 2 – PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. The computer program utilized for the analysis shall be nationally distributed and in wide use. Software algorithms shall comply with requirements of standards referenced in this specification and reports shall comply with IEEE 399.
- B. Acceptable Manufacturers.
 1. EasyPower by Bentley Systems
 2. ETAP
 3. SKM Systems Analysis, Inc.

PART 3 – EXECUTION

3.1 POWER SYSTEM DATA

- A. Single-line diagram.
 1. Include the product specific data for all components considered in the study. Equipment labeling tags shall be consistent with the electrical distribution system diagrams shown on the Drawings.
 2. Equipment types, model, and ratings shall be displayed. Transformers and generators shall include kVA, impedance data, and voltage information. Motors shall include horsepower. Feeders shall display conductor size and length.
- B. Impedance diagram shall indicate resistance and reactance of feeders.

3.2 FAULT CURRENT STUDY

- A. Maximum Momentary (1/2 cycle) and Interrupt (5 cycle) rms symmetrical fault currents shall be calculated for both three-phase bolted fault and phase to ground fault conditions. Separate calculations shall be performed for normal power sources and alternate power sources if they exist.
- B. Utilize single-line diagrams to display fault currents for different conditions and scenarios.
- C. Equipment Duty Report shall verify interrupt ratings of overcurrent protective devices comply with associated ANSI/IEEE standards.
 1. The tabulation type report shall indicate the overall maximum available fault current at each device and the device's short-circuit withstand rating.
 2. The report shall highlight any devices with areas of concern and/or inadequacies. These issues shall be promptly brought to the Engineer's attention.

3.3 COORDINATION STUDY

- A. The protective device study shall be developed to provide selective coordination of overcurrent protection devices in areas of the distribution system required by the NEC. All other areas of the distribution system shall be coordinated to the greatest extent possible so as to minimize (localize) outages during fault clearing.
 - 1. If any aspects of the system coordination are found to be unacceptable by either the Coordination Study Engineer or the Project Engineer, the Equipment supplier shall be responsible for costs associated with any required circuit breaker frame or trip module changes.
- B. Device settings shall fully protect feeders and equipment in accordance with associated IEEE standards. Settings shall not result in nuisance tripping of devices due to inrush or magnetization of equipment.
- C. In order to minimize arc flash hazard, pick up and time delay settings of each device shall be set as low as possible without compromising system coordination, damage protection, and nuisance tripping.
- D. Log type time/current curves shall be submitted that graphically illustrate the coordination of devices installed in series of a circuit. Provide separate sets of curves for alternate power source scenarios. Each Coordination Curve shall show the following information:
 - 1. Device labels
 - 2. Time/current curves of each overcurrent protection device, cut off at maximum fault-current point.
 - a. Sensor settings shall be displayed with the device label.
 - 3. Transformer damage curves and inrush points.
 - 4. Feeder damage curves.
 - 5. Motor starting curves.
 - 6. Provide separate plot curves for primary and secondary systems of transformers.
- E. A tabulation type summary of selected settings for all overcurrent protection devices shall be included in the submittal.
- F. Where selectivity cannot be achieved, the Engineer of Record shall be promptly notified of the cause and any recommendations available.

3.4 ARC FLASH STUDY

- A. Upon approval of all overcurrent protection device settings, provide arc flash calculations in accordance with IEEE 1584-2018 method to determine the Arc Flash Boundary and Incident Energy for all equipment included in the study.
- B. The calculations for each piece of equipment shall be based on the upstream trip device. Do not incorporate the fault clearing properties of any "Main Overcurrent Device" that is integral with the equipment.
- C. Provide a tabulation type report that includes estimated arc fault ampacity and time, arc flash boundary, and incident energy.
 - 1. If the system includes circuit breakers that incorporate arc flash reducing maintenance bypass functions, provide additional tabulation reports for all downstream devices with the bypass active.

3.5 INSTALLATION

- A. Test, calibrate, and adjust the overcurrent protective devices as recommended in the Coordination Study.

1. Furnish letter of verification that all overcurrent protective device settings have been properly adjusted. Verification shall be performed by the power study engineer, a representative of the power study engineer, or the engineer of record. List date of inspection, name of inspector, and names of any other persons in attendance.
- B. Install ANSI type Arc Flash Labels in accordance with NFPA 70E on all associated electrical equipment.
1. Labels shall be 4" x 6" self-adhesive vinyl.
 2. Include Boundary and Incident Energy information.
 3. Include Equipment name and upstream fed by information.
 4. Include available fault current.
 5. Include date of calculation.

END OF SECTION

**SECTION 26 0583
CONNECTIONS TO EQUIPMENT****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. The Contractor shall provide operational electrical connections to all electrically driven or controlled equipment.

PART 2 – PRODUCTS**2.1 MATERIALS****A. General**

1. The Contractor shall provide all necessary materials and labor required to make final operational connections to all equipment, generally as shown on the Drawings, and specifically as required by equipment specifications and installation literature.
2. Control devices and panels furnished by others will be delivered to the contractor at the jobsite, and shall be installed in accordance with manufacturer's printed instructions. Review equipment specifications to determine extent of work involved.

PART 3 – EXECUTION**3.1 GENERAL**

- A. Provide operational connections for all equipment shown on the Drawings. Connections shall be in accordance with manufacturer's recommendations, and shall be left operating in a manner acceptable to the Engineer and Owner.
- B. Provide available fault current calculations for equipment listed in Section 260500-1.4E based on actual installation criteria (conductor lengths, raceway types, etc.). Calculations shall incorporate the current limiting effects of fuses supplied with local disconnecting means. Include calculation information in Record Manuals.
- C. For all exterior mechanical equipment, provide weatherproof GFCI receptacle outlet within 25' of equipment, circuited to nearest unswitched power. Refer to NEC 210.63 and 406.8.
- D. For all mechanical equipment located in attic and crawl spaces, provide porcelain lamp holder with integral receptacle and lamp guard, circuited to nearest unswitched power via pilot handle toggle switch near access hatch. Engrave plate. Refer to NEC 210.70(C).

3.2 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 0943
NETWORK LIGHTING CONTROL SYSTEM****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. It is the intent of this Specification to provide all necessary equipment as detailed, for a complete lighting control system.
2. The work included under this Specification shall cover:
 - a. All labor, materials and equipment to furnish the lighting control system herein specified.
3. The work shall include the services of a commissioning agent. The commission agent shall be a factory-trained representative who shall commission the system for proper operation and instruct the Owner as to proper operation, programming, and maintenance.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Submit floor plan drawing indicating all device locations and circuitry requirements between devices.
3. Provide connection/riser diagram for specific project involved. Upon Engineer's review, provide **additional three** copies for Contractor use at the project site and for Record Drawing/Manual submittal at project closeout.

B. Manuals

1. Provide information in accordance with Section 260500. Manuals shall include descriptions of equipment and methods of maintenance and operations.

PART 2 – PRODUCTS**2.1 CONTROL SYSTEM COMPONENTS**

- A. Component communication shall be by low voltage hard wired protocol and/or by a wireless mesh network.
- B. Switches, modules, and sensors shall be as indicated on the drawings.
 1. Unless otherwise indicated on the Drawings, wall switches and sensors for wireless control systems shall be powered by line voltage. Battery powered devices not acceptable.
 2. Switching relays that are utilized for emergency egress lighting shall be in conformance with UL 924.

2.2 NETWORK INTERFACE

- A. Provide all hardware to create a fully connected lighting control system that allows for end user access to the connected (wired/wireless) lighting system devices via LAN.
 1. Lighting control devices and equipment included in the network shall be as indicated on the Drawings. They shall include, but not be limited to public areas, ice rinks, turf building, corridors, stairwells, private spaces, and exterior building/site.

2. Where the system includes wireless devices, include adapter/area modules as required to interface wireless devices with the network. Manufacturer responsible for quantity of modules to ensure coverage of wireless devices.
3. Manufacturer: Cooper WaveLinx CORE system, Lithonia nLight ECLYPSE system, or approved equal.

B. Connected System Interface.

1. Interface shall be accessible via free operational software package and/or onboard web GUI. Connections shall utilize HTTPS (industry-standard certificate based encryption).
2. Interface shall allow for daily, weekly, monthly, and calendar scheduling of events via time-of-day, photocontrol, and astronomical clocks.
3. The system shall allow users to monitor, control, and make adjustments to all connected devices. It shall provide real time energy usage data.
4. The system shall supervise all connected devices, and provide real time alarms for System faults. Alarms shall include context-sensitive troubleshooting tips.
5. The system shall include a gateway to integrate with BACnet protocol building automation systems.
 - a. BACnet integrator shall be able to monitor, adjust, and control all devices similar to lighting network.
 - b. BACnet integrator shall be able to obtain lighting system energy usage data.

2.3 CELLULAR REMOTE ACCESS SERVICE

- A. Provide all hardware to allow for commissioning agent remote access to the system via cellular modem. Communication through this system shall be for the lighting control system only. Devices that allow unrestricted communication are unacceptable.
1. Provide Cellular Router with integral firewall and SIM compatibility for connection to national carriers available at the project site.
 2. Sim Card and cellular plan shall be included. End user shall not be required to purchase any additional equipment or data plan.
 3. Remote access service shall remain active for 1 year, starting at the date of substantial completion. After the initial service expires, the end user shall have the option to continue this service at an agreed upon fee.
 4. Remote access functionality shall include, but not be limited to:
 - a. Device setting updates
 - b. Schedule updates
 - c. System performance optimization
 - d. Diagnostics.
 5. Remote access shall be enabled through outbound communication from the router to an outside source. Systems that begin communication via inbound network access requests are unacceptable.
 6. Encryption shall be TLS1.2 or greater.

2.4 SEQUENCE OF OPERATIONS

- A. The following descriptions are intended to provide a baseline operational platform for the system. All specific operating points shall be verified with the end user. If not acceptable to the end user, alternative points shall be offered and approved by the Engineer.
1. Ice Rinks/Turf Area:
 - a. Individual zone raise/lower as indicated on drawings
 - b. Preset lighting levels selectable in rinks/turf area based on footcandle levels for desired events.

- c. Wall switches for manual control option.
- 2. Individual Office/Locker Rooms:
 - a. Occupancy Sensors shall operate in Occupancy Mode (auto on, auto off) after 30 minutes.
- 3. Corridors
 - a. Schedule as directly by owner.
 - b. Wall switches deactivated during scheduled "on" time.
 - c. Off sweep every 2 hours of scheduled "off" time.
- 4. Parking Lot
 - a. Dusk-to-Dawn operation.
 - b. Maintain 100% until 11:00 pm.
 - c. Occupancy Mode Dim to 20% after 11:00 pm.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store Lighting Control Components in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

- 1. Install where shown on Drawings, plumb and level.
 - 2. Top of trim 6'-3" above finished floor for wall-mounted panel.
 - 3. Conductors neatly dressed and banded with nylon cable ties.
 - 4. From each flush installation, stub three additional 3/4" conduits into nearest accessible ceiling space to provide for future utilization of spare circuits.
 - 5. Provide 3/4" plywood backing for all surface-mounted panels.
 - 6. Provide individual terminal or lug for each wire. Multiple wires to common terminal or several terminals for single stranded conductor not acceptable.
- B. Provide low voltage cabling from control panel to peripheral devices as per manufacturer's instructions. Provide raceway system where concealed in walls, in mechanical rooms, and rooms without accessible ceilings. Cable shall be plenum-rated where installed above accessible ceilings and not in raceway.
- C. Provide engraved identification nameplate for system cabinet as per Specification 260553.
- D. Provide control station identification as per Drawings.

3.3 TESTS

- A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative. The commissioning agent shall configure the system as per the sequence of operation, make any adjustments/additions to the configuration as required or instructed, and verify the complete operation of the entire system.
 - 1. Electrical contractor shall notify owner and engineer twenty one (21) working days in advance to scheduling system commissioning.
- B. Furnish a letter of verification to Engineer indicating that the system has been tested and configured by manufacturer's representative and is found to be complete and functional. List date of test and name of manufacturer's representative. Testing to include a functional test of all devices and verification of proper configuration for all devices. Notify Owner and Engineer one week in advance of scheduled tests.

- C. As part of the required project close out Record Manuals, provide documentation on the commissioning of the system including room by room description indicating:
 - 1. Sensor parameters, time delays, sensitivities and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc).
 - 3. Load parameters (e.g. blink warning, etc).

3.4 INSTRUCTIONS

- A. After system commissioning is complete, the commissioning agent shall provide the Owner with complete instructions as to proper operation and maintenance of the lighting control system.
- B. Record instructions and include with manual in accordance with Section 260500.

3.5 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 2200
TRANSFORMERS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide power transformers for voltage transformation where shown on Drawings.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Include:
 - a. Primary and secondary voltage.
 - b. KVA rating.
 - c. Impedance.
 - d. Wiring diagram.
 - e. Quantity and percentage taps.
 - f. Dimensions.
 - g. Weight.
 - h. Any other pertinent information.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include:
 - a. Shop Drawing submittal.
 - b. Installation and maintenance instructions furnished with transformer by manufacturer.
 - c. Provide available secondary terminal fault current calculation based on actual transformer impedance. In lieu of infinite primary buss, utilize actual available primary fault current in the calculation.

1.3 QUALITY ASSURANCE**A. Codes and Standards**

1. Construct and rate all transformers in accordance with UL Standard 506, National Electrical Codes, American National Standard Institute Specification C57.12 and National Electrical Manufacturers Association Specification ST-20.
2. Transformer losses and efficiencies shall be in compliance with the U.S. Department of Energy's requirements.

PART 2 – PRODUCTS**2.1 TRANSFORMERS****A. Rating**

1. Dry type, three phase 480 Delta primary and 120/208 Wye secondary.
2. KVA rating: Scheduled on Drawings.

B. Cores

1. High grade, non-aging silicon steel.
2. Maximum magnetic flux densities substantially below saturation level.
3. Core laminations clamped and compressed to provide quite operation.
4. Core and coil assembly bolted to enclosure base, but isolated by means of rubber, vibration-absorbing mounts.
5. No metal-to-metal contact between core and coil assembly and enclosures.
6. Sound isolating systems requiring complete removal of all fastening devices not acceptable.
7. Core electrically grounded to enclosure by means of flexible copper grounding strap.

C. Sound Levels

1. Quiet type with design level which operates at/or below published NEMA standards.

KVA	NEMA Standard Sound Level
0-9	40
10-50	45
51-150	50
151-300	55
301-500	60

D. Coils

1. Aluminum conductors.
2. Continuous wire wound construction.
3. Impregnated with thermo-setting varnish.
4. Final wrap of electrical insulating material to prevent mechanical injury to coil.

E. Primary taps

1. Ratings less than 15 KVA: Two 5% FCBN taps.
2. Ratings 15 KVA and larger: Two 2-1/2% FCAN and four 2-1/2% FCBN taps.

F. Insulation Systems

1. Class 220°C insulation, 115°C temperature rise.
2. 115°C temperature rise not to be obtained by use of forced air cooling or by over-ventilating coil.

G. Enclosures

1. Sheet metal, degreased, phosphatized and finished with baked outdoor enamel.
2. VENT GUARD/RODENT GUARD REQUIRED ON ALL EXTERIOR LOCATIONS.

H. Wiring Compartments

1. Adequately sized for compliance with NEC.
2. Listed for 75° C wire.
3. Locate at bottom of transformer.
4. Rigidly mounted terminals to accommodate wiring lugs.
5. Enclosure temperature rise not to exceed 35°C rise above a 40°C ambient.
6. Rating 10 KVA and less: Non-ventilating enclosure.
7. Rated above 10 KVA: Ventilated enclosure with openings designed to prevent accidental access to energized parts.
8. Weatherproofed for exterior locations.

I. Manufacturer

1. All transformers shall be supplied by the same manufacturer.
2. Manufacturer's nameplate to include:
 - a. Manufacturer's name.
 - b. Primary and secondary voltages.
 - c. KVA rating.
 - d. Serial number.
 - e. Catalog number.
 - f. Impedance.
 - g. Wiring diagram.
 - h. Degrees temperature rise.
 - i. NRTL listing.
3. Sizing and design based upon Acme equipment; Acme catalog numbers utilized for reference.
4. Other acceptable manufacturers: Approved equal units by Hevi-Duty, Jefferson, MGM, or panelboard manufacturer.
5. Contractor is cautioned to verify all physical dimensions of "equal" units prior to accepting quotation for bid.

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store transformer in a cool, dry space prior to installation.

3.2 INSTALLATION**A. General**

1. Stub feeder conduit directly into wiring compartment.
2. Where conduit stubs are impractical, or for suspended installations, connect to feeder by means of flexible metal conduit. Use liquidtight flexible metal conduit in damp areas.
3. Support suspended transformers from structural members of sufficient capacity with rods and trapeze hangers.
4. Examine area to receive transformers to ensure adequate clearance for installation.
5. Provide fused disconnect switch adjacent to transformer when required by NEC Article 240.21(C)(5).

B. Grounding

1. Ground transformer in accordance with NEC Article 250. Refer to NEC 250.30 for grounding separately derived systems.

C. Identification

1. Provide nameplate identification in accordance with Section 260553 for all transformers.
2. Example:

Transformer T2
480-120/208 Volts, 75 KVA
Fed From Panel HP2

D. Concrete Pads

1. Locate floor mounted transformer on concrete pad.
2. Dimensions: 4" high and extend minimum 4" from all sides of transformer.
3. Provided by Division 26. Coordinate installation.

3.3 TESTS

- A. Check output voltage and select correct tap to achieve the rated nominal voltage.

END OF SECTION

**SECTION 26 2413
SWITCHBOARDS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide switchboard as shown on Drawings.

B. Description of System

1. Factory assembled, metal enclosed unit for distribution of power from line to feeders, installed and tested in place.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Show all details, including:
 - a. Conduit entrance area.
 - b. Electrical ratings.
 - c. Nameplate nomenclature.
 - d. Single line diagrams.
 - e. Bus bar details (size, arrangement and spacing.)
 - f. Short circuit withstand rating, and applicable series rating for this particular riser/fault current combination.
 - g. Switch rating and location.
 - h. Any other pertinent data, including UL 891 listing.

B. Record Manuals

1. Submit information in accordance with Section 260500.
 - a. Include fault current available at buss. Fault current calculations shall be based on actual installation criteria (conductor lengths, raceway types, etc.)
2. Include installation and maintenance instructions accompanying equipment.

1.3 QUALITY ASSURANCE**A. Codes and Standards**

1. Construct and rate all switchboards in accordance with Underwriters Laboratories Standard 891, National Electrical Code, ANSI and NEMA Standards.

PART 2 – PRODUCTS**2.1 GENERAL**

- A. Sizing and design based upon Eaton equipment; Eaton catalog numbers used for reference.
- B. Other acceptable manufacturers: Approved equal units by panelboard manufacturer.

- C. Contractor is cautioned to verify all physical dimensions of "equal" units prior to accepting quotation for bid.
- D. NRTL-listed; and "suitable for use as service equipment" when required.
- E. Provide barriers in all service switchboards that will isolate service bus bars and terminals from the remainder of switchboard.
- F. Feeder risers are schematic only, and not intended to infer lug arrangements. Contractor to indicate desired lug arrangements and sizes on Shop Drawings.

2.2 SWITCHBOARD

A. General

- 1. NEMA Class 1.
- 2. Dead front type.
- 3. Completely metal enclosed.
- 4. Provide switching devices as shown on Drawings.

B. Switching Device - Circuit Breaker

- 1. Breaker Types:
 - a. Under 400 ampere: Molded case, quick-make, quick-break thermal magnetic type, unless otherwise indicated.
 - b. 400 ampere and over: Solid-state molded case circuit breakers:
 - 1) Breakers shall contain electronic sensing, timing and tripping circuits.
 - a) Long time current
 - (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - b) Short time current
 - (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - c) Instantaneous current
 - (i) Adjustable current pickup
 - d) Ground fault.
 - (i) Where required by the NEC unless otherwise indicated
 - (ii) Adjustable current pickup
 - (iii) Adjustable time delay
 - 2) Include energy reducing maintenance switch with indicating light for
 - a) Devices serving as Service Disconnect.
 - b) Devices serving as Main Disconnect of separately derived systems.
 - c) All breakers greater than 1000 amps.
- 2. Trip and voltage ratings as shown on Plans.
- 3. Minimum 65,000 SCCR rated.
 - a. NRTL tested and certified series combinations acceptable.
- 4. Removable from front of switchboard without disturbing adjacent units.

C. Bussing

- 1. 98 percent conductivity copper.
- 2. Braced for short circuit stresses equivalent to available fault current.
- 3. Extend vertical cubicle bussing full height, excluding end gutters.
- 4. Provide full capacity copper neutral bus entire length of switchboard assembly.
- 5. Provide full capacity copper equipment ground bus entire length of switchboard assembly.

6. Provide means for future expansion.

D. Enclosure

1. Each section to be of welded and bolted construction, consisting of side frames, horizontal channels and angels, with removable top, sides and front plates.
2. Include bottom base channels and angles to permit jacking or moving section on rollers.
3. All sections to include provisions for mounting lifting angles.
4. Finish: Gray baked enamel over a phosphate rust-inhibiting primer.
5. Unless noted otherwise, nominal 36" wide, 90" high and 36" deep.
6. Gutter spaces 8" minimum on sides and 12" minimum on ends.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store switchboard in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Examine area to receive switchboard to ensure adequate clearance for installation.
2. Install switchboard plumb and level in accordance with manufacturer's installation instructions.
3. Adjust operating mechanisms for free mechanical movement.
4. Tighten bus and lug connections and mechanical fasteners.

B. Identification

1. Identify switchboards and switching devices in accordance with Section 260553.
2. Provide nameplate similar to following example:

Switchboard No. 1
120/208 Volt 3 Ø 4 W
600 Amperes

Minimum 2" X 6" with 3/8" letters. Locate on blank panel near top.

3. Provide nameplate identification in accordance with Section 260553 of these Specifications for all switching devices indicating load served. Locate on front surface of switch door. Do not use schedule numbers, but indicate load served.
4. Provide pressure sensitive tape identification in accordance with Sections 260553 and 262813 of these Specifications for all fusible switches.

C. Concrete Pad

1. Locate switchboard on concrete pad.
2. Dimensions: 4" high and extend minimum 4" from front and sides.
3. Provided by Division 26. Coordinate installation.

3.3 GFPE TESTING

A. Performance Testing

1. Performed when first installed on site, prior to being energized by utility transformer.

2. Primary current injection method shall be used for testing purposes per NEC 230.95-C.
3. Conducted in accordance with manufacturer's instructions.
4. Conducted in presence of manufacturer's representative.
5. Provide letter of verification to Engineer indicating:
 - a. Date of test
 - b. Name of manufacturer's representative

3.4 INSTRUCTIONS

- A. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 2416
PANELBOARDS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide panelboards where indicated and scheduled.

1.2 SUBMITTALS**A. Shop Drawings:**

1. Submit information in accordance with Section 260500. Show all details of:
 - a. Lugs.
 - b. Locations for grounding bar, neutral bar and directory.
 - c. Main bus amperage and arrangement.
 - d. Weight and physical dimensions of enclosures.
 - e. Cover and lock type.
 - f. Quantity of spaces.
 - g. Quantity, arrangement, amperage and short circuit withstand ratings in RMS amperes for all circuit breakers.
 - h. Any other pertinent data.
 - i. Applicable series rating for this particular riser/fault current combination.

B. Record Manuals

1. Submit information in accordance with Section 260500.
 - a. Include fault current available at buss. Fault current calculations shall be based on actual installation criteria (conductor lengths, raceway types, etc.)
2. Include installation and maintenance instructions accompanying equipment.

PART 2 – PRODUCTS**2.1 MANUFACTURER**

- A. Product of same manufacturer.
- B. Sizing and design based upon Eaton equipment; Eaton catalog numbers utilized for reference.
- C. Other Acceptable Manufacturers.
 1. Approved equal units by Siemens or Square D.
- D. Contractor is cautioned to verify all physical dimensions of "equal" units prior to accepting quotation for bid.

2.2 GENERAL

- A. Provide sub-feed lugs, contactors, main breakers or other equipment as scheduled.
- B. Provide copper bus, copper isolated neutral bar and copper grounding bar in all panelboards.

- C. Use load centers only where specifically indicated. Provide copper bus with plated aluminum neutral and grounding bar.
- D. NRTL-listed, and "suitable for use as service equipment" when required.
- E. Feeder risers are schematic only and not intended to infer lug arrangements. Contractor to indicate desired lug arrangements and sizes on shop drawings.
- F. Connection from load side of main breaker to panel bus shall be bus bar. Insulated wire and backfed types not acceptable.
- G. NRTL-recognized series ratings acceptable, with minimum ratings as specified herein.

2.3 BRANCH CIRCUIT PANELBOARDS

A. Circuit Breakers

- 1. Bolt-on.
- 2. Breaker Types:
 - a. Under 400 ampere: Quick-make, quick-break, thermal magnetic unless otherwise indicated.
 - b. 400 ampere and over: Solid-state molded case circuit breakers:
 - 1) Breakers shall contain electronic sensing, timing and tripping circuits.
 - a) Long time current
 - (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - b) Short time current
 - (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - c) Instantaneous current
 - (i) Adjustable current pickup
 - d) Ground fault.
 - (i) Where required by the NEC unless otherwise indicated
 - (ii) Adjustable current pickup
 - (iii) Adjustable time delay
 - 2) Include energy reducing maintenance switch with indicating light for
 - a) Devices serving as Service Disconnect.
 - b) Devices serving as Main Disconnect of separately derived systems.
 - c) All breakers greater than 1000 amps.
- 3. Trip indicating.
- 4. Common trip on multi-pole breakers; handle ties not acceptable.
- 5. Minimum SCCR rating:
 - a. NRTL tested and certified series combinations acceptable.
 - 1) 10,000 for systems up to 240 volts.
 - 2) 35,000 for 277/480 volt systems.
- 6. Single pole 15 and 20 ampere ratings to be NRTL-listed as "Switching Breakers" and carry SWD marking.
- 7. FIRE ALARM EQUIPMENT
 - a. Circuit breakers feeding fire alarm control panels and/or other fire alarm equipment shall be equipped with a pad-locking device capable of locking the circuit breaker in the closed position.

B. Bus Assembly and Temperature Rise

- 1. Rating: As scheduled.
- 2. 98 percent conductivity.

3. "Distributed phase" or "Phase sequence" type bus bar connections.
4. Adjacent single pole breakers connected to opposite polarities.
5. Multi-pole breakers installable in any location.
6. Provisions for additional breakers such that field addition of connectors or mounting hardware will not be required.

C. Wiring Terminals

1. NRTL-listed as suitable for type of conductor specified.

D. Circuit Numbering

1. Starting at top, odd numbers in sequence down lefthand side and even numbers in sequence down righthand side.

E. Cabinet

1. Enclose bus assembly in steel cabinet.
2. Wiring gutter sizes and steel gauge in accordance with NEMA and NRTL standards.
3. Fabricate box from galvanized steel or equivalent rust resistant steel.
4. Furnish **without** pre-punched knockouts.

F. Fronts

1. Code gauge, full finished steel with rust inhibiting primer and baked enamel finish.
2. Not removable with door in locked position.
3. Adjustable trim clamps.
4. Concealed steel hinges.
5. Door with tumbler-type cylinder lock, catch and spring-loaded door pull.
6. Flush lock not to protrude beyond door front.
7. Key all locks alike.
8. Circuit directory frame and card with clear plastic covering on inside of door.

G. Manufacturer

1. Eaton Pow-R-Line series.

2.4 POWER DISTRIBUTION PANELBOARDS

A. Circuit Breakers

1. Bolt-on.
2. Breaker Types:
 - a. Under 400 ampere: Quick-make, quick-break, thermal magnetic.
 - b. 400 ampere and over: Solid-state molded case circuit breakers:
 - 1) Breakers shall contain electronic sensing, timing and tripping circuits.
 - a) Long time current
 - (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - b) Short time current
 - (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - c) Instantaneous current
 - (i) Adjustable current pickup
 - d) Ground fault, where required, with integral test and reset buttons.

- (i) Adjustable current pickup
 - (ii) Adjustable time delay
 - 2) Main disconnect devices shall include maintenance-mode override.
 - 3. Trip indicating.
 - 4. Common trip on multi-pole breakers; handle ties not acceptable.
 - 5. Equipped with individually insulated braces and protected connectors.
 - 6. Front faces of all circuit breakers to be flush with each other.
 - 7. Affix large, permanent, individual circuit numbers to each breaker in uniform position.
 - 8. Minimum 35,000 SCCR rated.
 - a. NRTL tested and certified series combinations acceptable.
 - B. Bus Assembly and Temperature Rise
 - 1. Rating: As scheduled.
 - 2. Insulated bus structure.
 - 3. 98 percent conductivity.
 - 4. "Distributed phase" or "phase sequence" type bus bar connections.
 - 5. Adjacent single pole breakers connected to opposite polarities.
 - C. Wiring terminals
 - 1. NRTL-listed as suitable for type of conductor specified.
 - D. Cabinet
 - 1. Enclose bus assembly in steel cabinet.
 - 2. Wiring gutter sizes and steel gauge in accordance with NEMA and NRTL standards.
 - 3. Fabricate box from galvanized steel or equivalent rust resistant steel.
 - 4. Furnish **without** pre-punched knock-outs.
 - E. Fronts
 - 1. Minimum 12-gauge, full finished steel with rust inhibiting primer and baked enamel finish.
 - 2. Circuit directory frame and card with clear plastic covering.
 - F. Safety Barriers
 - 1. As required by UL or other NRTL.
 - G. Manufacturer
 - 1. Eaton Pow-R-Line series.
- 2.5 CABLE TIES**
- A. Thomas and Betts Company "Ty-Rap" or equivalent.
- 2.6 PLYWOOD BACKING FOR SURFACE MOUNTED PANELBOARDS.**
- A. 3/4" grade AD, fire-resistant, painted gray (including edges).

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store panelboards in a cool, dry area prior to installation.

3.2 INSTALLATION

A. General

1. Install where shown on Drawings, plumb and level.
2. Top of trim 6'-3" above finished floor for wall-mounted panelboard.
3. Adjust operating mechanism for free mechanical movement.
4. Conductors neatly dressed and banded with nylon cable ties after final load balancing.
5. From each flush installation, stub three additional 3/4" conduits into nearest accessible ceiling space to provide for future utilization of spare circuits.
6. Provide 3/4" plywood backing for all surface-mounted panelboards.
7. Tighten all lugs in accordance with manufacturer's recommendations.
8. Provide individual terminal or lug for each wire. Multiple wires to common terminal, or several terminals for single stranded conductor not acceptable.

B. Identification

1. Identify panelboards and directories in accordance with Section 260553.
2. Provide nameplate similar to following example:

PANEL L6
120/208 VOLT 3Ø 4W
2" C – 4 #3/0
FED FROM SWBD #1

3. When required, provide identification as per NEC 210.5(C) at each branch circuit panelboard.

C. Concrete Pad

1. Locate floor mounted panelboard on concrete pad.
2. Dimensions: 4" high and extend 4" from front and sides.
3. Provided by Division 26. Coordinate installation.

3.3 TESTS

A. Balancing Load

1. Circuiting shown on Drawings is designed to produce equal loading on all phases.
2. Under actual operating, check and make circuit adjustments as required to produce balanced condition.

B. GFPE Testing

1. Performed when first installed on site, prior to being energized by utility transformer.
2. Primary current injection method shall be used for testing purposes per NEC 230.95-C.
3. Conducted in accordance with manufacturer's instructions.
4. Conducted in presence of manufacturer's representative.
5. Provide letter of verification to Engineer indicating:
 - a. Date of test.

- b. Name of manufacturer's representative present.

3.4 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 2713
ELECTRIC SERVICE****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide electrical service from Montana Dakota Utilities Company's point of connection to main switch.

B. Description of System

1. 277/480V, 3-Phase, 4-Wire

PART 2 – PRODUCTS**2.1 METERING**

- A. CT metering.
- B. Utility company to furnish all instrument transformers and meters.
- C. Meter Sockets: Provide as required by utility company.

2.2 TRANSITION CABINETS**A. Construction**

1. 12-gauge galvanized phosphated steel.
2. Primed and painted one coat forest green enamel.
3. Lift off covers - both sides.
4. Padlocking handle with two point latch mechanism.
5. Penta head sealing bolt.
6. No trough openings, or furnish NEMA 3R cover plates.

B. Bus Assembly

1. Amperage as indicated on Drawings.
2. Copper bus bar.
3. Prepunched to NEMA standards for up to five utility company lugs.
4. Compression lugs on load side.
5. Ground stud.
6. Provision for bar type CT's.

- C. Manufacturer: Shallbetter CB series, or approved equal by American Midwest Power, Inc., Electro Mechanical Industries, Inc., or States Electric Mfg. Co.

PART 3 – EXECUTION**3.1 INSTALLATION**

- A. Verify with utility company prior to Bid all specific equipment requirements, installation requirements and fees particular to this service installation and make allowances thereto.

- B. Include in Bid all utility company fees and charges associated with service installation.
- C. Include in Bid all miscellaneous lugs, ground rods, site and pad conduits, sleeves, and other appurtenances required for service installation and not provided by utility company.
- D. Transformer and Equipment Pads
 - 1. Concrete pads provided by Division 26.
 - 2. Size per utility company requirements.
 - 3. Coordinate installation.
- E. Contractor totally responsible for all utility company coordination, metering equipment placement, and transformer location, with respect to service installation.
- F. Service installation shall comply with "Electric Service Rules and Regulations" as published by Montana Dakota Utilities Company.
- G. Cabinets
 - 1. Install cabinets in accordance with Code, product listing and manufacturer's recommendations.
 - 2. Install where shown on Drawings.
 - 3. Plumb and level.
 - 4. Top of trim 6'-3" above finished floor.

3.2 IDENTIFICATION

- A. Identify cabinets with nameplates in accordance with Section 260553.
- B. Inscription as directed by Engineer.
- C. Provide available fault current calculations for cabinets based on actual installation criteria (conductor lengths, raceway types, etc.). Include calculation information in Record Manuals.

3.3 CLEAN UP

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

SECTION 26 2726
WIRING DEVICES AND DEVICE PLATES**PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide wiring devices complete with device plates of matching or specified color. Wiring devices include receptacles for the connection of portable equipment and switches used for the control of both lighting and fractional horsepower motor loads. Also included are dimmers, occupancy sensors, photoelectric switches and time switches.

B. Work Installed But Furnished by Others

1. Where indicated, install devices furnished by other Divisions of this Specification.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.

B. Record Manuals

1. Provide information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying the equipment.

PART 2 – PRODUCTS**2.1 GENERAL**

- A. Device color: Gray or as selected by Architect. Verify with Architect. (Exception: Red devices on emergency circuits where applicable).
- B. All devices shall be of the same manufacturer, except where specifically noted otherwise with the phrase "NO SUBSTITUTION".

2.2 SWITCHES**A. AC Toggle and Keyed Switches**

1. 20-ampere 120/277 volt AC and HP rated.
2. Industrial Grade.
3. Color coded face or body by amperage.
4. Screw pressure plate back wire and side wire.
5. Federal Spec WS-896 listed.
6. Acceptable Manufacturers:
 - a. Cooper 2220 series
 - b. Hubbell 1220 series
 - c. Leviton 1220 series
 - d. Pass & Seymour PS20AC series

B. Pilot Light Switches

1. Neon lamp in red toggle handle, lit in "on" position.
2. 20 ampere, 120/277 volt AC rated.
3. Manufacturer: As listed above.

C. Time Switches

1. Two Circuit SPST switching, voltage rating as required.
2. Digital display with 7-Day programming.
3. Non-volatile program memory (battery backup unacceptable).
4. Manufacturer: Intermatic #ET2725 series.
5. Other acceptable manufacturer: Tork.
6. Special units as shown on Drawings.

D. Remote Photoelectric Switches

1. Threaded swivel mounting with locking nut and neoprene gasket.
2. Light level adjustment slide.
3. Activation: 1-5 footcandle on, 3-15 footcandle off.
4. Manufacturer: Intermatic #K4200 series, wattage and voltage as required.
5. Other acceptable manufacturers: Paragon, Area Lighting Research, Precision, or Tork.

E. Spring Wound Timer Switch

1. As shown on Drawings.
2. Manufacturer: Intermatic.
3. Other acceptable manufacturers: Area Lighting Research, Rhodes Mark Time, or Tork.

F. Occupancy Sensors

1. Ceiling Mount – Line Voltage
 - a. Self-contained line voltage unit with no external relays or power packs required.
 - b. Passive dual technology sensing combining passive infrared and ultrasonic/microphonic technology. Selective for initial and maintained triggering.
 - c. Rating: 120 VAC @ 800 watts, 277 VAC @ 1200 watts, electronic ballast rating. No minimum load requirements.
 - d. Ceiling-mount with 360° conical pattern coverage.
 - e. Adjustable time delay, from 5 to 20 minutes.
 - f. Automatic adjustment option for continuous time of day usage monitoring with automatic off delay adjustment.
 - g. Integral light level sensor to prevent turning lights on at selected light level between 10 and 300 footcandles.
 - h. LED activity Indicator.
 - i. Manufacturer: WattStopper #DT-355, Sensorswitch CMR-PDT series, Leviton ODC series, Hubbell OMNIDT-BP series, or approved equal.
2. Ceiling Mount – Low Voltage
 - a. Sensor:
 - 1) Self-contained low voltage unit obtaining 24 VDC power from external power pack.
 - 2) Passive dual technology sensing combining passive infrared and ultrasonic/microphonic technology. Selective for initial and maintained triggering.
 - 3) Ceiling-mount with 360° conical pattern coverage.
 - 4) Adjustable time delay, from 5 to 20 minutes.
 - 5) Automatic adjustment option for continuous time of day usage monitoring with automatic off delay adjustment.

- 6) Integral light level sensor to prevent turning lights on at selected light level between 10 and 300 footcandles.
- 7) LED activity Indicator.
- 8) Manufacturer: WattStopper #DT-300, Sensorswitch CM-PDT Series, Leviton OSC series, Hubbell OMNIDT series, or approved equal.
- b. Power Pack:
 - 1) Transforms an input voltage of 120, 240 or 277 VAC to Class 2 24 VDC to power remote sensors.
 - 2) Integral 20 amp line voltage relay with relay protection. Where circuit loads exceed 1920 watts @ 120 VAC or 4432 watts @ 277 VAC, provide two-pole power pack or additional single pole power packs as required.
 - 3) Provide quantities as required.
 - 4) Manufacturer: WattStopper #BZ series, Sensorswitch PP20 series, Leviton OPP20 series, Hubbell UVPP series, or approved equal.
3. Wall Mount
 - a. Self-contained line voltage unit with passive infrared sensing.
 - b. Rating: 120 VAC @ 800 watts, 240/277 VAC @ 1200 watts, electronic ballast rating. No minimum load requirements
 - c. PIR collector beams view out horizontally 35 feet in a wall-to-wall pattern, with a 20-foot effectiveness for small hand or body motions.
 - d. Adjustable time delay, from 5 to 20 minutes, with "OFF" override switch.
 - e. Automatic adjustment option for continuous time of day usage monitoring with automatic off delay adjustment.
 - f. Bypass mode to allow override button to act as a standard on-off switch in case of sensor failure.
 - g. Vandal resistant lens.
 - h. LED activity Indicator.
 - i. Multi-way version:
 - 1) Simultaneous load control from up to four device locations.
 - j. Dual-level version (ab switching):
 - 1) Two separate relays with dual override switches.
 - 2) Independent Auto or Manual mode per relay.
 - k. Manufacturer: WattStopper PW series, Sensorswitch WSX series, Leviton OSSMT series, Hubbell LHIR series, or approved equal.
4. Wall Mount with 0-10V Dimming
 - a. Self-contained line voltage unit with passive infrared sensing.
 - b. Rating: 120 VAC @ 800 watts, 240/277 VAC @ 1200 watts. No minimum load requirements.
 - c. Class 1 control of 0-10 Volt LED dimming for full range dimming control.
 - d. PIR collector beams view out horizontally 35 feet in a wall-to-wall pattern, with a 20-foot effectiveness for small hand or body motions.
 - e. Adjustable time delay, up to 30 minutes, with "OFF" override switch.
 - f. Multi-location capable.
 - g. Manufacturer: WattStopper PW-311, Sensorswitch WSX-D, Hubbell LHD-IRS series, or approved equal.

2.3 RECEPTACLES

A. General Purpose

1. 20 ampere, self-grounding, NEMA 5-20R, industrial specification grade.
2. Nylon face with finger grooves and compact body.
3. Minimum 0.032" triple wipe brass contacts.
4. Corrosion resistant steel strap interlocked with face and body.
5. Screw pressure plate back wire and side wire.
6. Tamper resistant.

7. Federal Spec WC-596 listed.
8. Acceptable Manufacturers:
 - a. Arrow Hart TR5362xx
 - b. Hubbell HBL5362xxTR
 - c. Leviton 5362-SGxx
 - d. Pass & Seymour TR5362xx

B. GFCI

1. 20 ampere, feed-through type.
2. Two utilization points per device, with vertical orientation.
3. Tamper Resistant.
4. Manufacturer: As listed above.

C. Combination Duplex and USB Charging

1. 20 ampere, Decora style.
2. Two utilization points per device, with vertical orientation.
 - a. Includes one USB-A port.
 - b. Includes one USB-C port.
3. 5 ampere, 5 Volt USB output.
4. Tamper resistant.
5. Manufacturers:
 - a. Arrow Hart TRUSBAC20
 - b. Hubbell USB20ACPD
 - c. Leviton M58AC
 - d. Pass & Seymour TR20USBAC6.

D. Damp & Wet Locations

1. All 15 and 20 ampere, 125 and 250 volt non-locking receptacles shall be listed weather-resistant type as per NEC 406.9(A) and 406.9(B)(1).
2. Manufacturer: As listed above.

2.4 DIMMERS**A. LED**

1. Control of 0-10 Volt LED dimming for full range dimming control.
2. Wattage as required by luminaire count in room.
3. Integral power pack for positive off.
4. Provide separate power pack if required by total room wattage.
5. Manufacturer: Lutron Diva Series #DVSTV.

2.5 DEVICE PLATES**A. Flush Interior**

1. Opening for device intended.
2. Thermoplastic type.
3. Manufacturer: Cooper, Hubbell, Leviton and Pass & Seymour.

B. Surface Interior

1. 1/2" raised cover

C. Damp & Wet Locations

1. Damp locations:
 - a. Refer to NEC 406.9(A).
 - b. Die-cast aluminum construction with stainless steel springs.
 - c. Unless indicated otherwise on the Drawings, Manufacturer: Pass & Seymour #4500 series or equivalent.
2. Wet locations:
 - a. Refer to NEC 406.9(B).
 - b. Unless indicated otherwise on the Drawings, Manufacturer: Red Dot #CKMU (horizontal) or #CKMUV (vertical), or approved equal by Hubbell.

PART 3 – EXECUTION**3.1 INSTALLATION****A. General**

1. Install device and plates where shown on Drawings in accordance with Code, product listing and manufacturer's recommendations.
2. Refer to Section 260534-3.1C for mounting heights.
3. Plumb and level.
4. Tight to wall.
5. Thoroughly cover wall opening around device.
6. Replace all devices and plates that become discolored or burned during construction.
7. Provide blank plates for unused openings.
8. Connect wiring devices by means of single conductor tails. Multiple wire connections not acceptable.
9. Tighten unused connection screws.

B. Identification

1. Identify wall switches which control lighting or equipment not in sight.
2. Refer to Section 260553-3.1C.

C. Receptacles

1. Vertical mounting with grounding pole at bottom.
2. Provide GFCI receptacles at NEC 210.8 locations.

D. Dimmers

1. No common neutrals.
2. Individually mounted: No gang mounting.
3. Do not remove any fins.

E. Photoelectric Switches

1. Install on roof, in center of structure where viewing from ground is minimal.
2. Verify exact location with Architect.
3. Penetrate roof with 3/4" RGSC, securely fastened to structure.
4. Provide flashing to maintain roof integrity.
5. Mount 18" above finished roof surface.
6. Make connections in weatherproof junction box.

F. Occupancy Sensors

1. Provide adequate supports to any structures, ceilings and grid system to safely attach sensors.
2. Mount external power packs (required only for low voltage sensors) within junction box in accessible ceiling space.
3. Verify operating parameters with Engineer.

3.2 TESTS

A. Proper operation of lighting switches, dimmers and occupancy sensors.

B. Duplex Receptacles

1. Proper connections.
2. Test all receptacles with NRTL listed receptacle circuit tester similar to Bryant #5266-PT, or Ideal #EZ Check.

3.3 INSTRUCTIONS

A. Instruct Owner's personnel in proper operation, setting, and maintenance of time switches, dimmers, occupancy sensors, and GFCI receptacles.

END OF SECTION

**SECTION 26 2813
FUSES****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide all fuses as required.

B. Work Furnished But Not Installed

1. Provide spare fuses for all sizes and classes required.
2. Quantity: 10%, with a minimum of three each rating, including motor starter control transformer fusing.

1.2 SUBMITTALS**A. Record Drawings**

1. Indicate actual class, type and size of fuse installed in each device.

B. Record Manuals

1. Submit information in accordance with Section 260500.

PART 2 – PRODUCTS**2.1 FUSES****A. Larger than 600 amperes.**

1. UL-listed, Class L.
2. Manufacturer: Bussmann Limitron KLU or "Hi-Cap" KRP-C, Littelfuse KLP-C, or Brush LCL.

B. 600 Amperes and Less Protecting Feeders or Combination Motor/Branch Circuit Loads.

1. UL-listed, Class RK-1.
2. Manufacturer: Bussmann LPN-RK/LPS-RK, Littelfuse LLN-RK/LLS-RK, or Brush LEN-R/LES-R.

C. Elevators

1. UL-listed, Class J.
2. Manufacturer: Bussmann LPJ-SP or Littelfuse JTD-ID.

D. Motor Starter Control Transformers

1. As recommended by manufacturer.

E. Plug Fuses

1. Dual element, UL-listed Type S with adapter.
2. Use only as indicated on Drawings for fused toggle switches.

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store fuses in a cool, dry space prior to installation.

3.2 INSTALLATION

- A. General

- 1. Install fuses in accordance with Code, product listing and manufacturer's recommendations.
 - 2. Verify equipment fuse sized for load prior to installation.
 - 3. All fuses shall be of same manufacturer.
 - 4. Do not mix fuse classes in individual applications.
 - 5. Fuses are not required for switchboard devices marked "Spare".

- B. Identification

- 1. Indicate on inside cover with pressure sensitive tape the size, voltage and type of fuse furnished for each device.

END OF SECTION

SECTION 26 2816
ENCLOSED SWITCHES & CIRCUIT BREAKERS**PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide disconnects where shown on Drawings or required by Code.
2. Provide enclosed circuit breaker where shown on the Drawings.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Indicate on submittal exact motor or equipment served.
3. Show all details including electrical ratings, enclosure dimensions and other pertinent data.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying the equipment.

PART 2 – PRODUCTS**2.1 DISCONNECT SWITCHES****A. Switch Interior**

1. Positive “off” position.
2. Lugs: NRTL-listed for aluminum and copper cable.
3. Plated current carrying parts.

B. Switch Mechanism

1. Quick-make, quick-break operating handle and mechanism.
2. Integral part of box.
3. Enclosures: Code gauge sheet steel (NEMA 1) or Code gauge galvanized steel (NEMA 3R).
4. Treat with rust-inhibiting phosphate primer.
5. Finish: Baked enamel.

C. Ratings

1. 240 or 600 volt.
2. Heavy duty.
3. Horsepower rated.
4. NRTL-listed "Suitable for Use as Service Equipment" when required.

D. Fusing

1. NRTL-listed rejection feature.
2. Reject all fuses except UL-listed Class R.

E. Manufacturer: Panelboard manufacturer.

2.2 ENCLOSED CIRCUIT BREAKERS

A. Breaker Types:

1. Under 400 ampere: Quick-make, quick-break, thermal magnetic unless otherwise indicated.
2. 400 ampere and over: Solid-state molded case circuit breakers:
 - a. Breakers shall contain electronic sensing, timing and tripping circuits.
 - 1) Long time current
 - a) Adjustable current pickup
 - b) Adjustable time delay
 - 2) Short time current
 - a) Adjustable current pickup
 - b) Adjustable time delay
 - 3) Instantaneous current
 - a) Adjustable current pickup
 - 4) Ground fault
 - a) Where required by the NEC unless otherwise indicated
 - b) Adjustable current pickup
 - c) Adjustable time delay
 - b. Include energy reducing maintenance switch with indicating light for
 - 1) Devices serving as Service Disconnect.
 - 2) Devices serving as Main Disconnect of separately derived systems.
 - 3) All breakers greater than 1000 amps.
3. Trip indicating.
4. Minimum SCCR rating:
 - a. 10,000 for systems up to 240 volts.
 - b. 35,000 for 277/480 volt systems.

B. Manufacturer: Panelboard manufacturer.

2.3 PLYWOOD BACKING FOR SURFACE MOUNTED SWITCHES

A. For interior locations, mount on 3/4" AD, fire-resistant, painted gray (including edges).

PART 3 – EXECUTION

3.1 STORAGE

A. Store disconnect switches or enclosed circuit breakers in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install all required disconnect switches or enclosed circuit breakers in accordance with Code, product listing and manufacturer's recommendations.
2. Plumb and level.
3. Tighten lugs in accordance with manufacturer's recommendations.

B. Identification

1. Identify disconnect switches or enclosed circuit breakers in accordance with Section 260553.

2. Nameplate required for all disconnect switches. Nameplate to include load served, voltage, horsepower or MCA rating, and fuse size. Nameplate to be installed inside of cover on exterior disconnect switches.

Example:

RT-1
480 Volt, 3 Ø
35 MCA, 40 A Fuses

3. Do not use schedule number, but indicate load served.
4. Pressure sensitive tape identification for disconnect switches containing fuses.
5. Voltage markers on all disconnect switches containing system voltages in excess of 250 volts to ground.

3.3 TESTING

A. GFPE Testing

1. Performed when first installed on site, prior to being energized by utility transformer.
2. Primary current injection method shall be used for testing purposes per NEC 230.95-C.
3. Conducted in accordance with manufacturer's instructions.
4. Conducted in presence of manufacturer's representative.
5. Provide letter of verification to Engineer indicating:
 - a. Date of test.
 - b. Name of manufacturer's representative present.

3.4 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 2822
ELEVATOR WIRING****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Power service connection.
2. Lighting service connection.
3. Telephone (voice) cabling.

B. Work not included

1. Telephone (located with elevator cab).
2. Control and interlock wiring.
3. Car normal and emergency lighting.

PART 2 – PRODUCTS**2.1 MATERIALS****A. Disconnect Switches**

1. Main power
 - a. Enclosed in single NEMA 1 enclosure.
 - b. Fusible switch with shunt trip capabilities.
 - c. Amp rating as scheduled on Drawings.
 - d. Class J fuses.
 - e. Control power transformer with fuses and blocks.
 - f. Fire safety interface relay with 120 VAC coil.
 - g. Key to test switch.
 - h. Green pilot light – “ON”.
 - i. Two mechanically interlocked NO/NC auxiliary contacts, Form C, 120 VAC-rated.
 - j. Fire alarm voltage monitoring relay (to monitor shunt trip voltage).
 - k. Integral Type 1 Surge Protective Device.
 - l. Manufacturer: Bussmann Power Module Switch PS series or Littelfuse Power-Switch LPS series.
2. Lighting Service
 - a. Minimum rating 115 volts 20 amperes.
 - b. Lockable enclosed circuit breaker, or fusible disconnect as per Specification Section 262816.

B. Pit Light

1. Refer to Section 265100.
2. LED strip fixture with lens and wire guard.
3. Minimum of 3,500 delivered lumens.

PART 3 – EXECUTION**3.1 PREPARATION**

- A. Coordinate entire installation with elevator system installer prior to installation of equipment.

- B. Provide available fault current calculations at elevator machine based on actual installation criteria (conductor lengths, raceway types, etc.). Calculations shall incorporate the current limiting effects of fuses supplied with local power module/disconnecting means. Include calculation information in Record Manuals.

3.2 INSTALLATION

A. Power Service

- 1. Verify exact disconnect location in elevator machine room with elevator system installer.
- 2. Provide power circuitry to elevator control panel as directed by elevator system installer.

B. Lighting Service

- 1. Verify exact disconnect location in elevator machine room with elevator system installer.
- 2. Provide separate 120 volt 20 ampere circuit to elevator control panel as directed by elevator system installer.

C. Elevator Pit

- 1. Verify pit light location with elevator system installer.
 - a. Light location shall provide at least 5 foot-candles on the entire floor area of the pit. Provide multiple pit lights if required.
- 2. Provide surface GFCI receptacle and toggle switch near pit access ladder.
 - a. Wire toggle switch to line side of GFCI receptacle, for control of pit light (non-GFCI).
- 3. Provide separate 120 volt 20 ampere circuit.

D. Telephone

- 1. Provide one Category cable, as specified in Section 271500, in 3/4" conduit from telephone service.
- 2. Stub into elevator machine room or machine space as directed by elevator system installer.

E. Machine Room or Machine Space (machine room-less application)

- 1. Lighting as shown on the Drawings.
- 2. Receptacles shall be GFCI.
- 3. Provide a dedicated 120 volt 20 ampere circuit for the machine room/space lighting and a dedicated 120 volt 20 ampere circuit for the machine room/space receptacles.

F. Fire Alarm System Interface

- 1. General
 - a. Fire alarm system interface shall initiate elevator Phase I Emergency Recall Operation in accordance with ASME A17.1 and NFPA 72.
 - b. Provide three elevator control outputs from the fire alarm system to the elevator control panel. The designated and alternate lobbies shall be determined by the local inspection authority.
 - 1) Designated Level Output: The first output shall be activated by the smoke detector(s) located in elevator lobbies other than the designated elevator lobby to initiate recall to the designated lobby.
 - 2) Alternate Level Output: The second output shall be activated by the smoke detector(s) located in the designated elevator lobby to initiate recall to the alternate level.

- 3) Machine Room Output: The third output shall be activated by the elevator hoistway and/or machine room or machine space smoke detector(s) to initiate recall to the designated lobby.
 - a) If the machine room or machine space is located at the same level as the designated lobby, the machine room or machine space smoke detector(s) shall activate the Alternate Level Output.
 - b) In multi car applications, each hoistway detector shall activate a distinct warning output to all adjacent cars.
 - c. Elevator control outputs shall consist of separately controlled NO/NC dry contacts from fire alarm individual addressable relay module(s) (Relay IAM).
 - d. Install elevator control circuits from Relay IAMs to elevator control panel as directed by elevator system installer.
 - e. Elevator control panel connection by elevator system installer.
 2. Hoistway smoke detector
 - a. Ceiling-mounted at top of hoistway.
 - b. Provide ceiling-mounted remote alarm indicator/test switch in top floor of adjacent elevator lobby area.
 3. Lobby smoke detector
 - a. Ceiling-mounted within 21 feet from centerline of elevator door opening.
 - b. Locations as indicated on the Drawings.
 4. Machine room smoke detector
 - a. Ceiling-mounted.
 5. Machine space smoke detector (machine room-less application)
 - a. Mounted on back-plane of machine equipment area. See detail on drawings.
- G. Fire Sprinkler System Interface
1. Refer to "Elevator Fire Sprinkler/Power Module Switch Interface" Detail on the Drawings.
- H. Entire installation to comply with elevator submittal drawings.

3.3 TESTING

- A. Prior to final inspection, verify that elevator electrical systems and fire alarm interfaces are in proper working condition, free from false alarms.
- B. Coordinate scheduling of all tests for elevator interfaces with elevator supplier, Local Fire Marshall or Fire Chief, and Owner.

END OF SECTION

**SECTION 26 2913
MOTOR STARTERS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide motor starters where shown and scheduled, or as required by Code.

B. Work Installed But Furnished Under Other Directives

1. Refer to Section 260500, Article 1.1, Paragraph D for extent of control devices furnished in other Divisions.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Show all details including electrical ratings, controls, schematic wiring diagrams, enclosure dimensions and other pertinent data.
3. Indicate on submittal exact motor or equipment served.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying the equipment.

PART 2 – PRODUCTS**2.1 GENERAL**

- A. Product of same manufacturer.
- B. Sizing based upon Eaton equipment.
- C. Other acceptable manufacturers: Approved equal units by Allen Bradley, Schneider, and Siemens.
- D. Contractor is cautioned to verify all physical dimensions of "equal" units prior to accepting quotation for Bid.

2.2 SINGLE PHASE MOTORS WITH INTEGRAL OVERLOAD PROTECTION

- A. Horsepower rated toggle switch, pilot handle where not in sight from motor.

2.3 SINGLE PHASE MOTORS WITHOUT INTEGRAL OVERLOAD PROTECTION**A. Manual Motor Starter**

1. Manually operated toggle switch with integral overload protection.
2. Rendered inoperative unless thermal unit is in position.
3. Provide pilot light for manual starters not in sight from motor.
4. Provide flush-mounted starters with stainless steel plates.

5. NEMA 1 enclosures for surface-mounted starters unless otherwise required by environment.

B. Fused Toggle Switch

1. 4" square box mounting.
2. Complete with fuse adapter and plug fuse of correct rating.
3. Manufacturer: Bussmann or Reliance.
4. **Use only where specifically shown.**

2.4 THREE PHASE AND SPECIFIED SINGLE PHASE MOTORS

A. Across-the-line

1. Magnetic type, non-reversing unless otherwise scheduled.
2. Rated in accordance with NEMA standards, sizes and horsepower ratings.
3. Provide combination fusible unit with Class R fuse holders, where disconnect and starter are shown at the same location.
4. Minimum size: NEMA size 0.
5. Manufacturer's series: Eaton Freedom series, or approved equal units by Allen Bradley 512 series, Schneider 8538 series or Siemens Class 17 series.
6. Control
 - a. 120 volt control transformer
 - b. Control fusing:
 - 1) 250 volt - in accordance with NEC.
 - 2) 600 volt - primary and secondary fusing regardless of VA rating of control transformer.
 - c. Cover-mounted devices for single-speed starters:
 - 1) Transformer operated LED green pilot light for running indication, with push-to-test feature.
 - 2) H-O-A selector switch, unless otherwise scheduled.
 - d. Cover-mounted devices for two-speed starters:
 - 1) Transformer operated LED pilot lights for running indication, with push-to-test feature: Green for low speed, amber for high speed).
 - 2) High-low-off-auto selector switch, unless otherwise scheduled.
 - e. Molded coil construction.
7. Overload Protection – exterior locations
 - a. Resettable overload protection on all phases.
 - b. Class 20 construction.
 - c. Starter inoperative if one or more overload units removed.
8. Overload Protection – interior locations
 - a. Self-powered.
 - b. Solid state construction with adjustable overload protection on all phases.
 - c. Manual reset with capability for remote reset function.
 - d. Phase loss protection.
 - e. Ambient-insensitive within operating range of -25°C to 55°C.
 - f. Solid state construction, Class 20.
 - g. Starter inoperative if overload unit is removed.
9. Electrical Interlocks
 - a. Space for minimum three, any arrangement NO or NC.

- b. Quantity: Two NO per starter.

B. Solid State Starters

1. Control and interlock options as previously indicated.
2. Run bypass contactor.
3. Class 20 overload protection.
4. Heavy-duty rating.
5. Temperature: NRTL-listed for -30 to 50°C ambient.
6. Rated for 4 starts per hour
7. Adjustable ramp times, torque control, and kick start.
8. Solid state reduced voltage type: Eaton 801+ Series.
9. Other acceptable manufacturers: As previously indicated.

2.5 THREE PHASE POWER MONITOR

- A. Provide for all three phase motors larger than two horsepower, and all three phase compressor equipment.

1. Not required for motors served by solid state starters or variable frequency drives.

- B. Line voltage to match system.

- C. Operating parameters:

1. Trip: 90% rated voltage on any or all phases.
2. Reset: 93% rated voltage on all three phases.
3. Dead band between trip and reset: 3%.
4. Repeat accuracy: 1% maximum at 0-70°C.
5. Trip Delay Time: Two seconds.
6. Reset: Two seconds.
7. Output contact rating: Pilot Duty, 470 VA @ 600 VAC.
8. Transient Protection: 2500 Volts for 10 MS.

- D. Special Options

1. NEMA 1 or 3R enclosure as required.
2. Adjustable Time Delayed Restart: 30-300 seconds. Set at 300 seconds.

- E. Manufacturer: Motor Saver Model 350.

- F. Other acceptable manufacturers: Eaton #D65 series.

2.6 PLYWOOD BACKING FOR SURFACE MOUNTED STARTERS

- A. 3/4" grade AD, fire-resistant, painted gray (including edges).

PART 3 – EXECUTION

3.1 STORAGE

- A. Store motor starters in cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Plumb and level.
2. Install motor starters in accordance with Code, product listing and manufacturer's recommendations.
3. Tighten all lugs in accordance with manufacturer's recommendations.
4. Verify correct size overload protection with motor nameplate data and manufacturer's recommendations.
5. Where power factor correction is specified for connection to motor terminals (i.e. load side of overload units), reduce overload rating as per manufacturer's recommendations.
6. Provide 3/4" plywood backing where several controls are shown grouped for surface mounting.

B. Identification

1. Identify motor starters in accordance with Section 260553.
2. Provide two nameplates for all motor starters: One for starter, other for equipment. Do not mount equipment nameplate on motor. Rather, mount on equipment, in visible location near motor.
3. Do not use motor schedule numbers, but indicate motor or load served.
4. Provide pressure-sensitive tape identification in accordance with Section 260553 and 262813 for all motor starters containing fuses.
5. Indicate proper thermal overload unit by circling correct number on chart affixed to cover of starter.
6. Provide voltage markers for all motor starters containing a system voltage in excess of 250 volts to ground.
7. Voltage markers not required for motor starters which form a part of a motor control center as specified in Section 262419.

3.3 TESTS

A. Proper operation.

B. Correct rotation.

C. Solid state motor starters

1. Furnish letter of verification to Engineer indicating solid state motor starters have been tested by manufacturer's representative.
2. List date of test and name of manufacturer's representative.

3.4 INSTRUCTIONS

A. Manufacturer's representative shall instruct Owner in proper maintenance and testing of solid state motor starters. Include name of Owner's representative in letter of verification.

B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.

B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 3213
GENERATOR SET****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. NFPA 110 Level 1, standby-rated, engine-generator set to supply emergency power to selected loads when normal power is not available.

B. Description of System

1. Upon failure of normal power, automatic transfer switch shall cause engine to start automatically, attain rated voltage and frequency, and transfer load.

1.2 SUBMITTALS**A. Submittals for Prior Approval to Quote**

1. Refer to Section 260500 for "Prior Approval to Quote" procedure.
2. Clearly indicate following on cover letter of submittal:
 - a. Combustion air CFM based on 110°F ambient.
 - b. Cooling air CFM based on 110°F ambient.
 - c. External static pressure capability of pusher fan (inches of water).
 - d. Unobstructed volume of radiator core available for cooling, cubic feet.
 - e. Heat rejection through cooling system.
 - f. Heat rejection to generator room.
 - g. Exhaust pipe size for particular distance of run.
 - h. Muffler dimensions.
 - i. Lift capacity of fuel pump.
 - j. Location of nearest maintenance and repair facility under the ownership of the supplier.
 - k. Any exceptions taken to technical requirements of Part 2, this Section.

B. Shop Drawings

1. Submit information in accordance with Section 260500.
2. Include complete data for maintaining and operating unit:
 - a. Fuel requirements.
 - b. Lubrication requirements.
 - c. Exercising.
 - d. Tests to be performed.
 - e. Spare parts list.
 - f. Trouble shooting guide.
 - g. Description of operation.
3. Provide multiple copies. One to remain with generator and the other copies for Record Manuals.

C. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying equipment.
3. Include written warranty and maintenance agreements.

1.3 QUALIFICATIONS

- A. Manufacturer: Company specializing in package engine generator sets with minimum five years documented experience.
- B. Supplier: Authorized distributor of engine generator manufacturer with service facilities within 350 miles of the project site.

PART 2 – PRODUCTS**2.1 GENERATOR SET****A. General**

- 1. Fuel: #1/winter blend diesel.
 - a. Off road dyed type acceptable for emergency standby applications.
 - b. On road type required for loadshed or prime power applications.
- 2. Engine driven, inline or V-type 4-cycle/stroke, 1,800 RPM with electronic governor.
- 3. Complies with current EPA regulations for nonroad engines of required hp.
- 4. Liquid cooled.
- 5. Furnish fuel pump, fuel filter with integral heater, and flexible fuel line.
- 6. Flexible fuel line to be braided metal, size as required.
- 7. Integral radiator with duct adapter.
- 8. Anti-vibration mounting pads between engine/alternator and base frame.
- 9. Heater
 - a. Water jacket type.
 - 1) Thermostatically controlled.
 - 2) Sized to maintain adequate block temperature to ensure prompt starting.
 - 3) Provide engine mounted isolation valves to facilitate removal and replacement.
 - 4) Provide one per in-line engine and one per bank for vee type engines.
 - 5) Manufacturer: Kim Hotstart or equivalent by generator supplier.
- 10. Safety Shutdowns.
 - a. NFPA 110 Level 1.
 - b. Dedicated shutdowns: Not to be included with monitoring functions.

B. Rating

- 1. Voltage, phase and kW ratings as shown on Drawings.
- 2. kW rating established at .8 power factor.
- 3. Adjust alternator size as required to accommodate large-motor starting transients and/or harmonics if applicable.
- 4. Voltage regulation + 2%, no load to full load.
- 5. 130° C temperature rise at full load.

C. Instrumentation

- 1. Electronic control panel, including (but not limited) to the following digital indications:
 - a. Oil pressure.
 - b. Coolant temperature.
 - c. AC voltmeter, ammeter, voltmeter/ammeter switch.
 - d. Running time meter.
 - e. Frequency meter. Electronic type. Vibrating reed and dial type not acceptable.
 - f. Integral start-stop engine controls.
 - g. 15 second crank with manual override.
 - h. NFPA 110 Level 1 safety indications.

2. Provide network interface module for web based access of all generator diagnostic information.

D. Remote Annunciator

1. Electronic control panel, including (but not limited) to the following digital indications:
 - a. NFPA 110 Level 1 safety indications with separate LED for each item.
2. Visual and audible, with silence button on horn.
3. Include required remote manual emergency stop station. Note: It will be acceptable to have this station as a separate device located adjacent to the remote annunciator

E. Output Circuit Breakers

1. Refer to Section 262416 for approved circuit breaker types.
2. Integral mounting. Field mounting not acceptable.
3. Quantity: one 225A/3P and one 100A/3P – both Solid-State CB

- F. Manufacturer: Caterpillar #D200 GC series or MTU #6R0113 DS200 series.

2.2 SUB BASE FUEL TANK AND ACCESSORIES

A. General

1. Integral skid-mount type, with wiring accessibility for underground conduit runs.
2. Sized for minimum 24-hour full-load operation.
3. Integral low fuel and high fuel contacts for remote annunciation.
4. Double wall design with leak detection system.
5. Constructed and tested in accordance with UL 142.

- B. Manufacturer: Klein, Tremont or equivalent by generator supplier.

2.3 MUFFLER

A. General

1. All welded construction.
2. Protected by high temperature, corrosion resistant coating.
3. Suitable for mounting in any position.
4. Rain cap, drip cap, and thimble.
5. Exhaust connector:
 - a. Flexible.
 - b. Stainless steel bellows type.
 - c. 18" minimum length.
 - d. Flanged connections for trade sizes 4" and larger.
 - e. Drain plugs.

- B. Size in accordance with manufacturer's recommendations, matched to specific engine use.

- C. Rating: Critical.

- D. Overall attenuation as required to meet the sound ratings of the enclosure as described in the Protective Housing section of this specification.

- E. Manufacturer: Riley Beaird, Inc., Maxim Silencer M51 series or equivalent by generator supplier.

2.4 STARTING BATTERIES**A. General**

1. Industrial-grade lead acid.
2. Sized to provide three 15-second crank cycles.
3. Include battery tester, cables and clamps.
4. Tray conforming to NEC 480.8.

2.5 BATTERY CHARGER**A. Cabinet**

1. Wall-mount with NEMA 1 or 3R type enclosure as required by location.

B. Indicators

1. DC ammeter.
2. DC voltmeter.

C. Electrical Characteristics

1. Overload protection.
2. Silicon diode full wave rectifiers.
3. Voltage surge suppressor.
4. Fused AC input.
5. 120 volt single phase input + 10%.
6. Float range (Volts DC per cell @ 25° C): 2.15-2.19.
7. Equalize range (Volts DC per cell @ 25° C): 2.25-2.45.
8. Charger to automatically select equalize mode whenever normal power is restored. Automatically switches back to float mode when normal equalizing potential reached.
9. Capacity: Sized for specific batteries utilized, to prevent undercharging and overcharging.

D. Manufacturer: Master Control System #MBC6 series.**E. Other acceptable manufacturers: La Marche or equivalent by generator supplier.****2.6 PROTECTIVE HOUSING****A. Weather-resistant**

1. The engine generator set shall be factory-enclosed in heavy gauge steel enclosure:
 - a. Constructed with corner posts, coated with electrostatically applied zinc and finished with baked enamel paint (color as selected by Owner from standard color options).
 - b. With large easily opened doors to allow access to the engine, generator and control panel. Each door shall be fitted with stainless steel, lockable hardware, with identical keys. padlocks do not meet this Specification.
 - c. Mounted on the generator frame and shall include 2" Aeroflex or equivalent insulation with motor-operated intake and pressure exhaust damper (dampers shall be located on opposite ends of the enclosure). Motor-operated dampers shall be spring operated to open and motor closed.
 - d. With snow hoods or internal louvers (intake and exhaust).
 - e. Muffler shall be integral to enclosure (not mounted on top of enclosure). Rain cap included. Attenuation as required to meet overall requirements.

- f. Package shall be pre-wired. All block heaters, battery chargers, unit heaters, etc. shall be wired by the manufacturer, facilitating a single point connection to a load center or fused terminal strip in the field.
 - g. With vermin proofing.
 - h. Sound levels shall be less than 75 dBA with full load at 7 meters.
- 2. Ductwork:
 - a. The installer of the generator set shall install a galvanized air discharge duct, with flexible section, between the engine radiator and the air exhaust louver/damper assembly.
- 3. Noise Attenuation:
 - a. As required to limit noise to 20 dBA measured at 25 feet from any point on the generator enclosure.

2.7 FUEL POLISHER

- A. Compact packaged apparatus including programmable controller, replaceable 3 micron water block filter, magnetic conditioner, and pump.
- B. Capable of polishing up to 640 gallons of fuel in 8 hours, 1.3 GPM flow rate.
- C. AXI International #FPS-DX-S or approved equal.
- D. Fuel polisher shall be factory installed/wired/plumbed inside the Generator Protective Housing.

2.8 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. Fuses: One for each type and rating used.
 - 2. Indicator Lamps: Two for each type used.
 - 3. Filters: Three additional sets of each fuel, oil, and air filter elements required for the engine.
 - 4. Fuel Polisher: Three additional water block filters and water block strainer baskets.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store generator in a cool, dry space prior to installation.

3.2 INSTALLATION

- A. Install generator in accordance with Code, product listing and manufacturer's recommendations.
- B. Provide Electrical Circuitry/Connections.
 - 1. Generator Power.
 - 2. Generator Engine Start Accessories.
 - a. Batteries.
 - b. Battery Charger: 20/1 circuit breaker.
 - c. Ignition.
 - 3. Generator Engine Heaters
 - a. Water jacket heater: 20/1 or 30/2 circuit breaker as required.
 - 4. Fuel System.
 - a. Tank float switch.
 - b. Solenoid valve - DC from engine.

5. Remote Annunciator
 - a. Generator.
 - b. Tank float switch.
 - c. Rupture alarm float switch.
- C. Provide network cabling in accordance with Division 27.
 1. Provide one cable, category type as required by Section 271500, from nearest data rack patch panel to generator. Provide conduit for cable for any exterior locations, or in exposed ceiling areas, to nearest cable tray. Cable may extend in cable tray to data rack. If no cable tray is available, extend cable above accessible ceiling spaces with proper supports as per Section 271500. Where any portion of cable is installed in conduit below grade, provide water-blocked cable.
- D. Concrete Pad
 1. Locate generator on concrete pad.
 2. Dimensions: Depth as indicated on the Drawings. Extend minimum 8" from all sides of frame.
 3. Verify and maintain required clearances as per manufacturer's recommendations.
 4. Provided by Division 26.
- E. Mount remote annunciator panel where indicated on Drawings. Provide raceway system and conductors as required.

3.3 START-UP AND TESTING

- A. Supplier of generator shall provide the services of a factory-trained technician at start-up and testing of the installation.
- B. Notify owner, engineer, and local fire Marshall or Fire Chief one week in advance of scheduled testing. Division 26 Contractor responsible for test coordination and scheduling.
- C. Provide full tank of fuel when owner occupies building. Refill tank at completion of installation and all testing.
- D. Factory-trained technician to perform tests as required and adjustments as needed. Tests shall include, but not be limited to:
 1. Phase Rotation Test (phase rotation to match normal power).
 2. Function test of all engine shutdown features such as low oil pressure, over-temperature, over-speed.
 3. Vibration test.
 4. Measure system charging voltage and individual cell voltages.
 5. Measure electrolyte specific gravity and level.
 6. Resistance load bank test:
 - a. Stepped sequence, no load to full load, timed for proper engine "break-in" to ensure proper ring seating.
 - b. Dry-type bank.
 - c. Two hours under full load.
 - d. Perform at project site.
 - e. Provide written report for Record Manuals.
 7. Automatic transfer switch operation and adjustment.

- E. Furnish letter of verification to Engineer indicating that the generator system has been tested by the manufacturer's factory-trained technician and is found to be complete and functional. List date of testing, name of factory-trained technician, and names of any other persons in attendance.

3.4 INSTRUCTIONS

- A. The generator supplier factory-trained technician shall instruct the Owner in proper operation, maintenance and testing of the complete generator system. Indicate on letter of verification, name of Owner's representative receiving instructions.
- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 WARRANTY

- A. Warranty shall be for a period of two years from date of project substantial completion, and shall include defective parts, workmanship, labor, mileage and travel time. Running hours shall not be limiting factor.
- B. Provide written warranty agreement.

3.6 MAINTENANCE SERVICE

- A. At substantial completion, begin 24 months full maintenance servicing by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventative maintenance as recommended by the manufacturer and adjusting as required for proper operation. Maintenance service shall include parts and supplies as used in the manufacture and installation of the original equipment along with all required labor, mileage, and travel time.
- B. Provide written maintenance agreement.

END OF SECTION

**SECTION 26 3600
TRANSFER SWITCHES****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide transfer switch for standby power system, in accordance with NFPA 110 Level 1, as shown on Drawings, and specified herein.

B. Description of System

1. Automatic transfer switch to stop and start emergency generator and transfer load from normal to emergency source.

1.2 QUALITY ASSURANCE**A. UL Standard 1008.**

- B. To ensure coordinated equipment operation and performance, and to centralize responsibility, equipment covered by this Section shall be furnished and warranted by the same supplier as the emergency generator.

1.3 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Include:
 - a. Amperage.
 - b. Voltage.
 - c. Phase pole quantity and neutral configuration.
 - d. Dimensions.
 - e. Installed weight.
 - f. Electrical connections.
 - g. Time delays.
 - h. Enclosure type.
 - i. Short circuit withstand rating.
 - j. Any other pertinent information.

B. Record Manuals

1. Submit information in accordance with Section 260500.
 - a. Include fault current available at each set of lug terminals. Fault current calculations shall be based on actual installation criteria (conductor lengths, raceway types, etc.). Provide separate calculation from normal power source and alternate power source; indicate calculated values for each.
2. Include manufacturer's instructions for maintaining and operating the transfer switch, including repair parts list, adjusting time delay relays, troubleshooting guide, wiring schematics and etc.
3. Provide multiple copies: One to remain with transfer switch, other copies for Record Manuals.

PART 2 – PRODUCTS**2.1 AUTOMATIC TRANSFER SWITCH**

- A. Ampere rating, voltage rating and phase pole quantity as indicated on the Drawings or as required by generator full load ampere rating.
- B. Use rating shown on standard specification sheet. Special ratings not acceptable.
- C. Mechanically held with open transition.
- D. Solid neutral.
- E. Time Delays
 - 1. NFPA 110 Level 1.
 - 2. Engine starting, adjustable .5 to 6 seconds. Factory set at one second.
 - 3. Transfer to emergency after emergency source attains 90% of rated voltage and 95% of rated frequency, adjustable 0 to 5 seconds. Factory set at .5 seconds.
 - 4. Retransfer to normal, adjustable 0 to 30 minutes. Delay automatically bypassed if emergency source fails and normal source is available. Factory set at 20 minutes.
 - 5. Engine cool down, adjustable 0 to 5 minutes. Factory set at 5 minutes.
- F. Test switch to momentarily simulate normal source failure.
- G. Auxiliary contacts, two NO-NC rated 10 amps, 480 V 60 Hz.
- H. Source identification signal lights.
- I. Microprocessor Controller:
 - 1. Undervoltage, overvoltage, underfrequency, overfrequency and voltage unbalance monitoring of both normal and emergency sources.
 - 2. Adjustable dropout and pickup set points for all five situations.
 - 3. Phase monitoring to control inrush currents at transfer.
 - 4. Generator exercising to be 7-day programmable with selectable “load” or “no load” testing.
 - 5. LCD display with keypad for menu driven control of set points, time delays and generator exerciser functions.
 - 6. Real time clock with battery backup.
 - 7. Include Ethernet communication module for network interface capabilities. Allows web based access to all parameters available at HMI.
- J. Manufacturer: ASCO 300 and 7000 series.
- K. Other acceptable manufacturers: Approved equal units by Russelectric Inc. (RMT series).

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store transfer switch in a cool, dry area prior to installation.

3.2 INSTALLATION

- A. Install transfer switch in accordance with Code, product listing, and manufacturer's recommendations.

- B. Securely mount transfer switch and accessories where shown on Drawings.
- C. Provide all control and power wiring/connections.
- D. Provide network cabling in accordance with Division 27.
 - 1. Provide one cable, category type as required by Section 271500, from nearest data rack patch panel to transfer switch. Provide conduit for cable for any exterior locations, or in exposed ceiling areas, to nearest cable tray. Cable may extend in cable tray to data rack. If no cable tray is available, extend cable above accessible ceiling spaces with proper supports as per Section 271500. Where any portion of cable is installed in conduit below grade, provide water-blocked cable.
- E. Concrete Pad
 - 1. Locate ATS on concrete pad.
 - 2. Verify and maintain required clearances as per manufacturer's recommendations.
 - 3. Provided by Division 26. Coordinate installation.

3.3 TESTS

- A. Test in conjunction with generator.

3.4 INSTRUCTIONS

- A. Manufacturer's representative shall instruct Owner in proper operation, maintenance and testing of complete transfer switch system. Representative shall assist the Owner in programming an exercise schedule that meets NFPA 110 Level 1 requirements. Indicate on Section 263213 letter of verification, name of Owner's representative receiving instructions.
- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 4313
SURGE PROTECTIVE DEVICES****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide integral Surge Protective Device in panelboards and switchboards where indicated and scheduled.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include installation and maintenance instructions accompanying equipment.

PART 2 – PRODUCTS**2.1 TYPE 2 SURGE PROTECTIVE DEVICE (SPD)****A. Provided only in panelboards and switchboards as indicated on the drawings.****B. The panelboard/switchboard manufacturer shall internally install SPD protection within the panelboard and the entire assembly shall be UL 67 listed.****C. SPD requirements:**

1. Listed and component recognized in accordance with latest editions of UL 1449, UL 96A and UL 1283.
2. Minimum surge capacity ratings as indicated on the drawings. Operating voltage and configuration as indicated on the drawings
3. 200kA Short Circuit Current Rating (SCCR). SPD devices obtaining SCCRs using upstream over current protection are prohibited.
4. 20kA nominal discharge current.
5. EMI/RFI noise filtering attenuation up to 50dB for 10kHz – 100MHz.
6. Self contained module design, with each suppression element metal-oxide varistor (MOV) based incorporating thermal protection. End of life mode shall be open circuit.
7. Surge current diversion paths between each phase conductor and the neutral conductor, between each phase conductor and the ground and between the neutral conductor and ground. For delta configured systems, the SPD shall have components connected between each phase conductor and between each phase conductor and ground.

8. UL 1449 latest edition listed and recognized component voltage protection rating (VPR) shall not exceed:
- | VOLTAGE | L-N | L-G | N-G | L-L |
|------------|-----------|-----------|-------|-------|
| 240/120 1Ø | 700V | 700V | 700V | 1200V |
| 208Y/120 | 700V | 700V | 700V | 1200V |
| 240D/120 | 700/1200V | 700/1200V | 700V | 1800V |
| 480Y/277 | 1200V | 1200V | 1200V | 2000V |
9. Designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
10. Equipped with on board visual and audible diagnostic monitoring devices mounted on the front cover of the SPD.
- Indicating lights shall provide full time visual diagnostic monitoring of the operational status of each phase of the surge current diversion module.
 - Audible diagnostic monitoring shall be by way of audible alarm. This alarm shall activate upon a fault condition. An alarm on/off switch shall be provided to silence the alarm.
 - LCD display surge counter located on the front cover of the SPD. Counter shall be equipped with a manual reset with protection from accidental operation and utilize non-volatile memory.
 - A set of Form "C" dry contacts shall be provided for remote annunciation.
11. Warranty: The panelboard manufacturer shall warranty the SPD for full replacement if destroyed by transients, including lightning, for a period of ten (10) years.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. SPD protection modules shall be factory installed by the panelboard/switchboard manufacturer integral to the panelboards/switchboards indicated on the drawings. Each entire assembly shall be UL 67 listed.

3.2 TESTS

- A. Verify all SPD equipment is active and in proper working condition prior to final project inspection.

3.3 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 26 5100
LUMINAIRES****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Furnish and install a complete luminaire for each lighting outlet.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500 including voltage, housing and door frame material, lens type, diffuser thickness, lumen output, and color temperature.

B. Record Manuals

1. Provide information in accordance with Section 260500.

1.3 COORDINATION

- A. Confirm compatibility and interface of luminaire with other materials and job conditions prior to ordering. Report discrepancies to Engineer and defer ordering until clarified.
- B. Provide frames, trim rings, and backboxes as required.
- C. Coordinate with work of all other Divisions to avoid conflicts between luminaires, supports, fittings and mechanical equipment. Ceiling clearances are minimal. It is imperative that Contractors coordinate conduit and duct runs to facilitate luminaire installation as shown on reflected ceiling plans. Engineer will not be responsible for interferences arising from lack of field coordination between trades.

PART 2 – PRODUCTS**2.1 LUMINAIRES****A. General**

1. UL or other NRTL listed.
2. Where shown to be installed in fire-rated assemblies, luminaires shall be listed in accordance with UL Standard 1598. Supplemental penetration protection (tenting) will be accomplished by General Contractor in accordance with UL Fire Resistance Directory. Coordinate installation with General Contractor. Supplemental protection shall be spaced minimum 1/2" away from the luminaire, per UL Standard 1598.
3. Verify ceiling finishes and equip all recessed luminaires with appropriate frames as required.
4. Furnish luminaires intended for use in lay-in grid ceilings with proper clips for compliance with NEC.
5. Refer to Section 260500 for "Prior Approval to Quote" procedure.

B. LED Lighting Systems

1. General: All LED lighting system components must be UL or other NRTL listed.
2. Light Engines:

- a. Meets or exceeds 70% lumen maintenance at 50,000 hours based on IESNA LM-79-2008.
 - b. Minimum 80+ CRI rating.
 - c. 4000K color temperature, or as scheduled on drawings.
 - d. Minimum delivered lumens as scheduled on drawings.
3. Electronic drivers for LED's:
 - a. Factory installed.
 - b. Multi-volt for use on either 120v or 277v systems.
 - c. THD: < 20%.
 - d. Factory installed quick-disconnect plug internal to the luminaire for driver removal.
 - e. Rated for a minimum of 50,000 hours.
 - f. 0-10 Volt dimming standard. Provide non-dimming drivers only as scheduled.
 - 1) Controls and wiring as per manufacturer's recommendations. Provide power packs for wall-box dimmers as required for positive luminaire off.
4. Downlights shall incorporate integral diffuser type lens. Exposed modules not acceptable.
5. Emergency battery packs:
 - a. Include self-testing/self-diagnostics with audible alarm option.
 - b. Factory installed.
 - c. Minimum lumens as scheduled.
6. Spare Drivers:
 - a. Luminaire manufacturer shall keep reasonable driver stocks on hand for replacement of defective drivers under guarantee period.
7. Guarantee period: Minimum 60 months from date of substantial project completion.
 - a. Guarantee shall include all parts and labor required to bring luminaire to complete operation.
 - b. Labor shall be performed by an Owner approved Electrical Contractor licensed in the area the work is to be performed.
 - c. Any costs for equipment rentals required to service luminaires under warranty shall be the responsibility of luminaire manufacturer.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store luminaires in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install luminaires plumb and true, free of light leaks, warps, dents and other irregularities.
2. Equip any outlets not specifically labeled with a luminaire the same as those in rooms used for similar purposes.
3. Run all directional lenses the same direction in rooms, corridors and other adjacent areas that contain square luminaires.
4. Continuous row luminaires: Hang level in straight line and butt tightly together.
5. Verify exact location of luminaires with reflected ceiling plan. Any discrepancies between the lighting plan, reflected ceiling plan, or installed ceilings shall be brought to the attention of the Engineer for clarification prior to installation.
6. Coordinate with Mechanical Contractor in advance of installation to prevent space conflicts.
7. Connect recessed luminaires to branch circuitry by means of single flexible metal conduit 6'-0" in length.

B. Barriers

1. Required where recessed luminaires are installed in insulated ceilings.
2. Suitable material to satisfy NRTL requirements.

3. Provided by Division 26 when not indicated otherwise.
4. Coordinate installation.

C. Luminaire Supports

1. Provide adequate supports to any structures, ceilings and grid systems to safely suspend or attach luminaires.
2. General Contractor to provide ceiling support systems as required by that portion of the Specifications. Electrical Contractor to provide any additional supports on an "as needed" basis to prevent ceiling from sagging or developing other irregularities.
3. Contractor responsible for providing proper suspension and mounting devices and to safely support all luminaires shown on Drawings, regardless of ceiling systems.
4. Rigidly support surface suspended ceiling system with anchors, hangers or clips designed for the purpose.
5. Support surface-mounted luminaires at four-foot intervals.
6. Install recessed luminaires in accordance with manufacturer's recommendations.
7. Rigidly support recessed luminaires to structural members or properly supported ceiling system with hangers, clips or fasteners designed for the purpose.
8. Support pendant and stem-hung luminaires at four-foot intervals.

D. 0 – 10 Volt Dimming Control Circuits

1. Installed in accordance with NEC Article 725.
2. Class 1 systems
 - a. #14 AWG THWN/THHN solid conductors installed in the same raceway as associated power wiring.
3. Class 2 systems
 - a. #18/2 non-shielded cable unless otherwise indicated on the drawings.
 - b. Plenum rated where required.
 - c. Cable shall be installed in raceway when concealed within walls, in mechanical rooms, and rooms without ceilings.
 - 1) DO NOT INSTALL IN SAME RACEWAY AS POWER CIRCUITRY.
 - d. Cable not required to be enclosed in raceway when installed above accessible ceilings.
 - 1) Route cables parallel or perpendicular to building construction.
 - 2) Support cables from building structure utilizing approved methods.
 - 3) Neatly coil excess cable length of pre-terminated assemblies.
 - 4) All cable runs shall be continuous between devices. NO SPLICING.

3.3 TESTS

- A. Upon completion of this portion of the Work and prior to its acceptance by Owner, check for proper alignment and operation of all lighting equipment.

3.4 CLEAN UP

- A. Clean all luminaires immediately prior to final inspection.

END OF SECTION

**SECTION 26 6510
OVERHEAD DOOR WIRING****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide all wiring and control equipment not furnished with overhead door, for complete and satisfactory operation.

B. Overhead door wiring includes:

1. Power connections.
2. Control station installation.
3. Control connections between limit switches, safety devices, and door operator.

C. Work Not Included

1. Refer to overhead door section of specification for extent of material furnished with door.

PART 2 – PRODUCTS**2.1 MATERIAL****A. Disconnect Switches**

1. Refer to Section 262816.
2. Separate switches required for each door.
3. Toggle switches acceptable for 115 volt rated motors.

B. Outlet Boxes

1. Refer to Section 260534.

PART 3 – EXECUTION**3.1 INSTALLATION**

- A. Install controller, push-button or key-operated stations for each overhead door. Provide conduit, boxes and wiring material required for electrical connection, including control cable connection to limit switches and safety devices.
- B. Where used, locate key-operated control stations on exterior of building, flush mounted. Seal conduit after conductor installation.

END OF SECTION

SECTION 27 0500
DIVISION 27 GENERAL PROVISIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The provisions and requirements of Section 260500 shall be applicable to Division 27.
- B. All Division 27 work shall be included under the Division 26 contract.
- C. The Contractor shall take special note that any conflicts between the Contractor and any Division 27 subcontractors shall not become an issue of the Engineer or Owner. It shall be the Contractor's responsibility to coordinate with the Division 27 subcontractor/s to determine where their work leaves off and where the subcontractor's work begins. The Contractor shall be responsible for all specified work including the operations of work under Division 27.

END OF SECTION

**SECTION 27 0528
NETWORK SYSTEMS ROUGH-IN****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide raceways for network systems as shown on the Drawings.

B. Work furnished and installed by others.

1. Local serving telephone utility shall place the service entrance cable to the point of presence, install circuit protection cabinet, protectors, and ground the entrance cable as needed to the service grounding conductor provided under this contract.

PART 2 – PRODUCTS**2.1 GENERAL**

- A. Main telephone terminal boards (TTB): 3/4" grade AD fire-resistant plywood, painted gray (including edges). Dimensions as required by serving utility company.

B. Voice/data terminal board (TTB):

1. 3/4" grade AD fire-resistant plywood, painted gray (including edges). Dimension as required by Owner's network system supplier. May be included with main telephone terminal board for single board installation.

C. Raceways:

1. As specified in Section 260533 and sized as shown on Drawings, minimum 1".

D. Boxes:

1. 2-1/8" deep unless restricted by wall thickness.
2. As specified in Section 260534 and 260540.

E. Blank plates:

1. As specified in Section 262726, yoke-mounted. Box-mounted plates not acceptable.

F. Firestop Assemblies

1. NRTL listed 4" square pathway with intumescent material designed to seal out fire, smoke, and toxic gases.
2. Quantity shall equal or exceed the width of the associated cable tray. i.e. a 6" wide tray requires two pathways.
3. Include mounting accessories as required by application specifics.
4. Manufacturer: EZ Path Series 44, 3M Model PT4SD or approved equal.

PART 3 – EXECUTION**3.1 INSTALLATION****A. Serving Communications Utility Requirements**

1. Raceways:
 - a. Provide telephone service entrance conduit, stubbed to terminal board from property line.
 - b. Verify service entrance conduit size and quantity, and property line location with serving utility.
 - c. Provide bushing or connector at each conduit stub.
 - d. Provide pull wire in each telephone conduit run.
2. Provide surface double-duplex receptacle at main telephone terminal board, fed from dedicated spare circuit breaker. Receptacles to be isolated ground type, with separate grounding conductor connected to panelboard grounding bar.
3. Provide telephone board communication grounding bus as required by serving utility, minimum #6 solid SDBC in conduit, extended shortest and most direct route to ground bar at main switch. Terminate in ground bar affixed to telephone terminal board, location as directed by serving utility.
4. Entire installation to comply with serving utility company requirements.

B. Raceways:

1. Stub from rough-in location to within 6" of nearest cable tray, or location as indicated on drawings.
2. Provide bushing or connector at each conduit stub.
3. Provide pull wire in each voice/data raceway.
4. Provide raceway system where concealed in walls, in mechanical rooms and rooms without accessible ceilings.

C. Provide blank plates for all rough-in boxes not concealed by Owner's voice/data equipment.**D. Entire installation to comply with Owner's network systems supplier requirements.****END OF SECTION**

**SECTION 27 1513
NETWORK CABLING****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide Network Cabling System as shown and described.

B. Work furnished and installed by others.

1. Voice: The Owner will provide all telephone handsets.
2. Data: The Owner will provide all end-user software, programming, computer servers, terminals and personal computers.
3. Surveillance: The surveillance system cameras, servers, switches and storage equipment will be provided and installed either by the Owner or under other Sections of this specification.

C. Description of System

1. Voice: Work shall include, but not be limited to, devices, faceplates, cables and cable assemblies, connecting blocks, cable management, terminations, and final acceptance testing.
2. Data: Work shall include, but not be limited to, devices, faceplates, cables and cable assemblies, cable management, patch panels, data racks, terminations, and testing.
3. Surveillance: Work shall include, but not be limited to, devices, cables and cable assemblies, cable management, patch panels, data racks, terminations, and testing.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Indicate:
 - a. Mounting details.
 - b. Connection diagrams.
 - c. Description of devices.
 - d. Name of installation Contractor/Subcontractor.

B. Record Manuals

1. Provide information in accordance with Section 260500.
2. Include manufacturer's data for adjustment, operation and maintenance of equipment and name of service organization.

PART 2 – PRODUCTS**2.1 MANUFACTURER/SUPPLIER**

- A. The system specified is based on equipment as manufactured by General Cable, Panduit, Commscope and other manufacturers as listed. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met. Backboards, conduit, cable tray, and rough-ins shall be by Electrical Contractor.

- B. Contractors/Subcontractors performing Section 271500 work shall have personnel trained/certified in communications cabling installation via equipment manufacturers' or industry standards' training programs. Refer to Section 260500-1.5 Quality Assurance.
- C. Acceptable installers:
1. Computer Store, 1100 S Broadway, Minot, ND 58701, 701/838-3967.
 2. Data Connections, 4016 37th Avenue NW, Mandan, ND 701/426-8771.
 3. Dell-Comm, Inc. 812 S 18th St., Bismarck, ND 58504, 701/222-2887.
 4. ECSI, 1711 12th Ave SW, Minot, ND 58701, 701/838-8401
 5. Gefroh Electric, 100 45th Ave NW, Minot, ND 58703, 701/838-0225.
 6. Innova Integrated Systems, 1800 22nd Ave SW, Minot, ND, 701/837-0131.
 7. Main Electric, 2626 Valley St., Minot, ND 58701, 701/852-3315.
 8. Muth Technology, 600 E Benson Rd, Sioux Falls, SD 57104, 800/888-1597.
 9. RBB Electric, 1123 N 1st St., Grand Forks, ND 58208, 701/775-7404.
 10. Wheeler Construction, 1720 South Broadway, Minot, ND, 58701, 701/852-5584.
 11. Installers not listed above and wishing to quote shall refer to Specification 260500-1.4 for approval procedure. No consideration shall be given to any installer not pre-approved.

2.2 DEVICES AND FACEPLATES

- A. Data jacks: Single outlet RJ45, eight-pin/eight wire, modular construction, TIA/EIA-568.2-D Category 6 compliant, T568A and T568B identification, Panduit Mini-Com #CJ688TG, Commscope #MGS400 series, Leviton #61UJK series, or approved equal.
- B. Voice jacks: Same as data jacks.
- C. Voice wall-mount face plate/jack assembly: Stainless steel with Category 6 keystone jack, Panduit #KWP6, Commscope #630B8, Leviton #4108W1SP series, or approved equal.
- D. Faceplates
1. Single gang with ID windows and two or four modular inserts as dictated by jack count shown on the drawings.
 2. 430 or 302/304 stainless steel, or as selected by Architect.
 - a. Panduit #CFPL2/4 series, Commscope #M12/14SP-L series, Leviton #43080-1L2/4 series, or approved equal.
 3. Where plastic plates are selected by Architect.
 - a. Panduit #CFPE2/4 series, Commscope #M12/14L series, Leviton #42080-2/4 series, or approved equal.
- E. Provide blank modules as required. Panduit #CMB, Commscope #M81, Leviton #41084 series, or approved equal.
- F. Color: Devices as selected by Owner, faceplates as selected by Architect.
- G. Surveillance Cameras
1. Jack assembly for cameras mounted to accessible ceilings shall utilize Panduit Model #CBXQ1IW-A enclosure mounted to building structure above the ceiling. Surveillance system provider shall be responsible for patchcord between camera and jack.
 2. Cameras mounted directly to rough-ins or surface boxes shall utilize cable terminated to RJ45 Plug, Panduit Model #FP6X88MTG field terminating type or approved equal. Provide minimum 12" extra cable length within rough-in or camera mounting equipment.

2.3 CABLES AND CABLE ASSEMBLIES

- A. Station cables (voice and data): Four unshielded, twisted pair, #23 gauge, Category 6 – 350 MHz, solid copper conductor, cable tray and plenum rated.
1. General Cable #7131900, Commscope #2088B, Berk-Tek #10032094 or equivalent meeting the following characteristics at 250 MHz.
 - a. ACR: 10.5 dB min. @ 100m
 - b. PS-ACR: 8.5 dB min. @ 100m
 - c. ELFEXT: 24.5 dB min.
 - d. PS-ELFEXT: 21.5 dB min.
 - e. NEXT: 43 dB min.
 - f. PS-NEXT: 41 dB min.
 - g. ATTEN.: 32.8 dB max. @ 100m
 - h. LCL: 26 dB min.
 - i. Return Loss: 20 dB min.
- B. Extended Range cable: Four unshielded, twisted pair, #22 gauge, Category 6, solid copper conductor, cable tray and plenum rated.
1. Limited power listed for up to 90 Watts (PoE Type 4)
 2. Certified for 10 Mbps transmission up to 250 meters.
 3. Certified for 1 Gbps transmission up to 200 meters.
 4. General Cable #8131800, Paige #258300336, or equivalent meeting the following characteristics at 250 MHz.
 - a. Insertion Loss: 30.6 dB/100m max.
 - b. Return Loss : 17.3 dB/100m min.
 - c. NEXT: 38.3 dB/100m min.
 - d. PSNEXT: 36.3 dB/100m min.
 5. Use only where indicated on the Drawings.
- C. Outside Plant cable: Four unshielded, twisted pair, #23 gauge, Category 6, solid copper conductor, gel filled water block for underground/wet applications and UV resistant insulation.
1. General Cable #7136100, Commscope #1572A, Berk-Tek #10139885 or equivalent meeting the following characteristics at 250MHz.
 - a. Insertion Loss: 32.8 dB max.
 - b. Return Loss : 17.3 dB min.
 - c. NEXT: 38.3 dB min.
 - d. PSNEXT: 36.3 dB min.
- D. Outside Plant Extended Range cable: Four unshielded, twisted pair, #22 gauge, Category 6, solid copper conductor, gel filled water block, wet listed, and extended range.
1. Limited power listed for up to 90 Watts (PoE Type 4)
 2. Certified for 10 Mbps transmission up to 250 meters.
 3. Certified for 1 Gbps transmission up to 200 meters.
 4. General Cable #8146100, Paige #258330804, or equivalent meeting the following characteristics at 250 MHz.
 - a. Insertion Loss: 30.6 dB/100m max.
 - b. Return Loss : 17.3. dB/100m min.
 - c. NEXT: 38.3 dB/100m min.
 - d. PSNEXT: 36.3 dB/100m min.

2.4 WIRELESS ACCESS POINT (WAP) CABLING**A. Cabling for WAP's shall be Limited Power Listed CAT 6A.**

1. Data jacks: Single outlet RJ45, eight-pin/eight wire, modular construction, TIA/EIA-568.2-D Category 6A compliant, T568A and T568B identification, Panduit Mini-Com #CJ6X88TG, or approved equal.
2. Above Ceiling Installation: Panduit #CBXQ2IW-A, or Approved Equal surface termination box attached to building structure.
3. Station cables: Four unshielded, twisted pair, #23 gauge, Category 6A – 500 MHz, solid copper conductor, cable tray and plenum rated. UL Listed CMP-LP (0.7A).
 - a. General Cable #7151850 or Approved Equal meeting the following characteristics per 100 meters at 500 MHz.

1) ACRF:	13.8 dB min.
2) PSACRF:	10.8 dB min.
3) PSAACRF:	32.0 dB min.
4) NEXT:	33.8 dB min.
5) PSNEXT:	31.8 dB min.
6) PSANEXT:	60.0 dB min.
7) Return Loss:	15.2 dB min.

2.5 MISCELLANEOUS PRODUCTS**A. Cable management:**

1. 6" die-cast aluminum distribution rings: Allen Tel #GB13C or equivalent.
2. Plenum velcro cable ties: Panduit #HLSP series or equivalent.
3. Cable hooks with retainers: B-Line #BCH series or equivalent.

B. Patch Panels

1. Patch panels shall have modular jack-style termination connectors, be 24-port or 48-port in size, one or two standard EIA rack spaces in height. The panels shall have separate port and panel designation strips. Panduit #CP24BL or #CP48BL, Commscope #M2400-1U-GS, Leviton #49255-H24 or #49255-H48, or approved equal.
2. Quantity: As required by station cable count.

C. Data Rack (DTR)

1. 84", floor-mounted, EIA/TIA 19" rack assembly. Panduit #R2P, Hoffman #EDR19FM45U, Chatsworth #55053-X03, or equivalent, quantity as shown on Drawings.
2. Provide horizontal cable management panels with integral bend radius control for front and rear cables. Size and quantity determined by cable and patch panel quantity. Panduit #NCMH2, Hoffman #DCHD2, Chatsworth #13930-702, or equivalent.
3. Provide full height 4"x5" vertical cable management panels for front and rear cables. Panels required on both sides of rack. Panduit #WMPV45E, Hoffman #DV6D7, Chatsworth #13915-703, or equivalent.

D. Identification:

1. Panduit #LS8E or Pan-Mark labeling systems or equivalent. Hand lettering not acceptable.

E. Power Strip:

1. 19" rack-mounted surge suppression strip with twelve NEMA 5-20 receptacles.
2. UL1449 listed. 30kA Maximum Surge. EMI/RFI Filtration.
3. Manufacturer: CyberPower #CPS1220RMS or equivalent.
4. Quantity: One per data rack.

2.6 COLOR

- A. All cables shall match their associated jack color for type of system served unless otherwise indicated.
- B. Verify cable and jack color configuration with Engineer/Owner's Rep.
- C. Typical color configuration.
 1. Voice Jacks – Match Faceplate (Yellow cable)
 2. Data Jacks – Yellow
 3. WAP – Orange
 4. Cameras – Purple

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store system equipment in cool, dry space prior to installation.

3.2 GENERAL

- A. Securely install components where shown on Drawings.
- B. Contractor shall adjust and provide all other assistance required at final inspection to bring the system satisfactorily on-line.
- C. Install in accordance with NEC, EIA/TIA Standards, NRTL listing, and manufacturer's recommendations and instructions.
- D. All cables that extend underground shall be listed for use in wet locations. See Outside Plant cables in Part 2 for requirements.
- E. Cable:
 1. Install cables in raceways as required by Section 270528 and in cable tray (communications type) where cable tray is specified.
 2. Route open air cables (where not in raceway or cable tray) parallel or perpendicular to building construction supporting with specified products, maximum 4'-0" on center.
 3. Bundle multiple open air cable runs located in TTB/TB rooms together with velcro cable ties
 4. Identify ends of cables with room designations as directed by Owner.
 5. Bending radius shall be minimum 1".
 6. All cable runs shall be continuous, **NO SPLICING**.

3.3 DATA

- A. Provide Data Rack(s) as shown and specified.
- B. Install patch panels and cable management system in Data Rack.

- C. Install data station cable from patch panel to data outlet locations as shown on the Drawings. Cable length not to exceed 295 feet.
- D. Terminate cables according to T568A or T568B wiring scheme as determined by Owner's system requirements.
- E. Extended range cable to only be used where indicated on the Drawings, or where approved by the Engineer. Use of this cable is not permitted as an alternative to change or alter network system distribution locations or quantities.
- F. Identify cable at both ends according to Owner's convention. Arrange patch panels and patch panel jacks as per Owner's convention. Identify all patch panels, patch panel jacks, and faceplate jacks according to Owner's convention.
 - 1. If no convention is available, room numbers shall be incorporated into the identification. Ex: For room 120, use 120-1 for first cable, 120-2 for second cable, etc.

3.4 SURVEILLANCE

- A. Install separate dedicated patch panels in Data Rack for the camera cables.
- B. Install station cable from patch panel to camera locations as shown on the Drawings. Cable length not to exceed 295 feet. Verify exact camera location and mounting configuration with Surveillance System installer.
 - 1. Extended range cable to only be used where indicated on the Drawings or where approved by the Engineer.
- C. Terminate cables according to T568A or T568B wiring scheme as determined by Owner's system requirements.
- D. Identify cable at both ends according to Owner's convention. Arrange patch panels and patch panel jacks as per Owner's convention. Identify all patch panels, patch panel jacks, and faceplate jacks according to Owner's convention.
 - 1. If no convention is available, camera numbers shall be incorporated into the identification. Ex: For camera 21, use C-21.

3.5 GROUNDING

- A. For each data rack, provide one #10 AWG solid copper conductor from data rack to nearest panelboard with equipment ground bus.
- B. Where multiple data racks are located in single room (more than 2), provide isolated communication grounding bus in room. Extend #6 solid SDBC in conduit, extended shortest and most direct route to ground bar at nearest panelboard with equipment ground bus. Extend one #10 AWG solid copper conductor from each data rack to communication grounding bus in room.

3.6 TESTING REQUIREMENTS

- A. All terminated voice and data cables shall be tested and certified for TIA/EIA-568.2-D. Category 6 standards. The test shall be performed on the permanent link configuration (from station jack to patch panel jack). These standards require the following when tested at 250 MHz:

1. Return Loss shall be no less than 10.0dB.
 2. Insertion Loss (Attenuation) shall not exceed 31.1dB.
 3. Near End Cross Talk (NEXT) shall be no less than 35.3dB.
 4. Power Sum Near End Cross Talk (PSNEXT) shall be no less than 32.7dB.
 5. Attenuation to Crosstalk Ratio Far-end (ACRF) shall be no less than 16.2dB.
 6. Power Sum ACRF (PSACRF) shall be no less than 13.2dB.
 7. Propagation Delay shall be less than 490 nanoseconds.
 8. Propagation Delay Skew shall be less than 44 nanoseconds.
- B. All terminated WAP cables shall be tested and certified for TIA/EIA-568.2-D. Category 6A standards. The test shall be performed on the permanent link configuration (from station jack to patch panel jack). These standards require the following when tested at 500 MHz:
1. Return Loss shall be no less than 8.0dB.
 2. Insertion Loss (Attenuation) shall not exceed 43.8dB.
 3. Near-end Cross Talk (NEXT) shall be no less than 26.7dB.
 4. Power Sum Near-end Cross Talk (PSNEXT) shall be no less than 23.8dB.
 5. Attenuation to Crosstalk Ratio Far-end (ACRF) shall be no less than 10.2dB.
 6. Power Sum ACRF (PSACRF) shall be no less than 7.2 dB.
 7. Propagation Delay shall be less than 490 nanoseconds.
 8. Propagation Delay Skew shall be less than 44 nanoseconds.
 9. Power Sum Alien Near-end Cross Talk (PSANEXT) shall be no less than 49.5 dB.
 10. Power Sum Alien Attenuation to Crosstalk Ratio Far-end (PSAACRF) shall be no less than 23.7 dB.
- C. Additional testing shall include line mapping and cable length before final acceptance by Owner.
1. DC resistance shall be less than 3% or less than 150 milli-Ohms.
- D. All permanent link cable runs shall be documented with a hard copy print-out of the test results. Compile one copy of test results in a loose-leaf binder, similar to manual references in Section 260500, 1.04E. Submit at project completion with referenced Record Manual.
- E. Field tester to be Level III and conform to TIA/EIA 568.2-D Annex A & B requirements.

3.7 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 27 1523
FIBER OPTIC CABLING****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide Fiber Optic Cabling System as shown and described.

B. Work furnished and installed by others.

1. The Owner will provide all end-user software, programming, computer servers, hubs/switches, media converters, and personal computers.

C. Description of System

1. Fiber optic work shall include but not be limited to raceway installation, pulling of fiber optic cable, splicing and terminating of cable assemblies and final acceptance testing.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.

B. Record Manuals

1. Provide information in accordance with Section 260500.

C. Record Drawings

1. Indicate exact locations of junction boxes containing cable for future connection.

PART 2 – PRODUCTS**2.1 MANUFACTURER/SUPPLIER**

- A. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality, and appearance that must be met.
- B. Acceptable installers/suppliers:
 1. Refer to Specification Section 271513, 2.1B&C.

2.2 FIBER OPTIC RACEWAY

- A. Corrugated, non-metallic, flexible raceway for use in plenum and non-plenum applications.
- B. Size as required or as indicated on Drawings.
- C. Provide associated fittings as required.
- D. Manufacturer: Carlon Plenum-Guard series or equivalent.

2.3 FIBER OPTIC CABLE

A. Multimode Cable

1. OFNP rated
2. 900 µm tight buffer twelve-fiber distribution style.
3. 50/125 µm diameter.
4. OM3 10Gb/s @ 850 nm for distances up to 300 meters.
5. Manufacturer: OCC #DX012TALE9QPI8 or approved equal.

B. Multimode Cable

1. OFNP rated
2. 900 µm tight buffer six-fiber distribution style.
3. 50/125 µm diameter.
4. OM3 10Gb/s @ 850 nm for distances up to 300 meters.
5. Manufacturer: OCC #DX006TALE9QPI8 or approved equal.

2.4 MISCELLANEOUS PRODUCTS

A. Wall Mounted Splice Box

1. One removable / tilt down splice tray.
2. Each splice tray capable of holding (6) splices with storage capacity of one meter of fiber per splice.
3. Lockable steel enclosure.
4. Manufacturer: Panduit FWME2 series or equivalent.

B. Connectors

1. Style and specifications as required by owners equipment.
2. Factory polished. **FIELD POLISHED CONNECTORS NOT ACCEPTABLE.**
 - a. Factory polished pigtails terminated to the distribution cable by either fusion splicing or mechanical splicing with gradient matching gel (Panduit Opti-Cam or equivalent).
 - b. Factory polished connector with mechanical termination directly to the distribution cable utilizing gradient matching gel (Panduit Opti-Cam or equivalent).
 - c. Pre-terminated cassette with pre-terminated MTP type fiber connector on the distribution cable.

C. Patch Panel

1. Standard 19" rack mounting tray with removable top cover. Integral slack storage spools.
 - a. Fiber Adapter Panels as required if utilizing pigtail connectors or Opti-Cam connectors.
 - b. Cassettes as required if utilizing MTP type system.
2. Manufacturer: Panduit FMT2 with CFAPPBL2 or approved equal assembly.

D. Identification:

1. Panduit # LS5 or Pan Mark labeling systems, or equivalent. Hand lettering not acceptable.

PART 3 – EXECUTION

3.1 STORAGE

- #### A.
1. Store fiber optic cable in cool, dry space prior to installation.

3.2 GENERAL

- A. Install in accordance with NEC, EIA/TIA Standards, product listing, and manufacturer's recommendations and instructions.
- B. Cable
 - 1. Route cables parallel or perpendicular to building construction.
 - 2. Cable to be enclosed in raceway as described in Section 2.02 of this Specification unless otherwise indicated on Drawings.
 - 3. Identify ends of cables as directed by Owner/Engineer.
 - 4. Bending radius as per cable specifications.
 - 5. All cable runs shall be continuous between termination points; NO SPLICING.

3.3 TESTING REQUIREMENTS

- A. All fiber optic strands shall be tested and certified for EIA/TIA 568 standards. These standards require the following:
 - 1. Attenuation loss not to exceed 3.0 dB/km @ 850 nm for 50/125 multimode cables and 0.65 dB/km @ 1310 nm for 9/125 single mode cables.
 - 2. 0.75 dB per mated pair of connectors.
 - 3. 0.30 dB per splice.
- B. Using a light source/power meter, test each fiber for overall attenuation loss. Submit meter readings for each fiber with Record Manuals.
- C. Electrical Contractor responsible for cost to replace all unsatisfactory cables due to breaks, fractures, and bad splices as determined by testing.

3.4 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 27 5116
PUBLIC ADDRESS SYSTEM****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide complete and operational Audio/Video System to support voice and audio program sources for the 3 ice rinks, commons space, the turf space and alternate areas if accepted. The system shall be controlled by a digital signal processor operated by touchscreen controllers with custom graphics.

B. Description of System

1. The system shall provide voice and music reinforcement of programming, from microphone, Bluetooth, and auxiliary locations where shown throughout the facility. Each system shall also provide signal reinforcement from the other systems if so selected.
2. The Rink 1 system shall be the master control. It shall have a local zone interface for Rink 1 area mic/wireless mic/auxbt inputs. It shall also have a second master operator interface to control Rink 1, Rink 2, Rink 3, Turf, and Commons.
3. The Rink 2 system shall have local zone interface for area mic/aux/bt inputs and availability of other system program sources if selected.
4. The Rink 3 system shall have local zone interface for area mic/aux/bt inputs and availability of other system program sources if selected.
5. The Turf system shall have local zone interface for area mic/aux/bt inputs and availability of other system program sources if selected.
6. The Commons system shall have local zone interface for area mic/aux inputs and availability of other system program sources if selected.
7. The Alternate Bid Playground system shall be an isolated system for area bt input.
8. The Alternate Bid Dryland system shall be an isolated system for area bt and portable wireless mic input.
9. Individual inputs shall be controlled via a touch-screen control system.
10. The system shall include two paging devices that override all zones for facility-wide announcements.
11. The system shall include a ducking function via a dry contact relay input from the fire alarm system (silence A/V system upon fire alarm activation).
12. All speakers/rigging, projectors/screens, and other equipment/devices included in this section shall be installed by the supplier listed in Part 2.1 of this section.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Indicate mounting details, cabinet dimensions, connection diagrams, cabinet equipment layouts, and description of system functions.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include information for operating and maintaining the system, including wiring diagrams, repair parts list, proper setting of controls, and all instructions accompanying equipment.
3. Provide multiple copies, one to remain in central cabinet, other copies for Record Manuals.

PART 2 – PRODUCTS**2.1 MANUFACTURER/SUPPLIER**

- A. The system specified is based on equipment as manufactured by Bi Amp, RDL, and other manufacturers as listed.
- B. All references to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met.
- C. Acceptable supplier:
 - 1. Forte, 1930 East Century Avenue, Bismarck, North Dakota, (701) 223-3800.
 - 2. TriCorne Audio Inc, 4023 State Street, Bismarck, North Dakota, (701) 258-6912.

2.2 PACP1**A. HEAD END EQUIPMENT****1. POWER AMPLIFIERS**

- a. Independent channel type.
- b. Frequency response: 20Hz to 20kHz.
- c. Standard 19” rack-mount type.
- d. Manufacturer: Biamp Model Voltera D Series.
 - 1) Quantity, power, and channels as shown on schematic drawings.

2. AUDIO PROCESSOR

- a. Digital Signal Processor.
- b. Frequency response 20Hz-20kHz.
- c. Configuration/Control via laptop RS 232 and Ethernet.
- d. 12 x 8 In/Out configuration.
- e. Dante Protocol
- f. Manufacturer: Biamp Tesira Forte Series.
 - 1) Quantity as shown no schematic drawings.

3. PoE SWITCH

- a. Provide PoE switch for control system power and networking.
 - 1) Switch shall be designed specifically for A/V applications.
- b. Extend cabling between all control equipment as necessary.

4. EQUIPMENT RACK

- a. Swing out sectional wall mount 19” rack.
- b. Lockable front cover.
- c. Sized as required for equipment.
- d. Include Surge Suppression type power strips as required.
- e. Include lockable drawer for microphone storage.
- f. Manufacturer: Lowell LWR Series or equivalent.

B. MASTER CONTROL PANEL

- 1. 8-inch touch-screen interface with custom graphics tailored to specific project.

2. PoE connection to processors.
3. Mounted to front face of Equipment Rack.
4. Manufacturer: Extron TLP Pro 835M.

C. REMOTE CONTROL PANELS (C1, CT, and CC)

1. Touch-screen interface module with custom graphics tailored to specific project and rotary knob.
2. PoE connection to processors.
3. 1-gang rough-in with Black faceplate.
4. Manufacturer: Biamp Apprimo TEC-X 1000

D. PAGING STATION (QTY 2)

1. Push-to-talk console with integral gooseneck microphone.
2. Keypad with LCD display.
3. PoE connection to processors.
4. Manufacturer: Biamp NPX G1100.

E. WIRELESS MICROPHONES

1. Wireless microphone system shall consist of all receivers, transmitters, bodypacks, antennas, lapel and lecture mics, and power supplies required for a complete and operational system.
 - a. (1) Shure SLXD4D+ series dual wireless receiver.
 - b. (2) Shure SLXD2+/SM58 wireless handheld transmitters.
 - c. (2) Shure UA825 series remote antenna (coax).
 - d. (2) Shure UA8 series antennas with brackets.

F. HEARING ASSIST SYSTEM

1. 2 Channel Wi-Fi broadcast system with four independent Receivers.
2. Manufacturer: Listen Technologies #LWS-04B-W1.

2.3 PACP2

A. HEAD END EQUIPMENT

1. POWER AMPLIFIERS

- a. Independent channel type.
- b. Frequency response: 20Hz to 20kHz.
- c. Standard 19" rack-mount type.
- d. Manufacturer: Biamp Model Voltera D Series.
 - 1) Quantity, power, and channels as shown on schematic drawings.

2. AUDIO PROCESSOR

- a. Digital Signal Processor.
- b. Frequency response 20Hz-20kHz.
- c. Configuration/Control via laptop RS 232 and Ethernet.
- d. 12 x 8 In/Out configuration.
- e. Dante Protocol
- f. Manufacturer: Biamp Tesira Forte Series.
 - 1) Quantity as shown no schematic drawings.

3. PoE SWITCH

- a. Provide PoE switch for control system power and networking.
 - 1) Switch shall be designed specifically for A/V applications.
- b. Extend cabling between all control equipment as necessary.

4. EQUIPMENT RACK

- a. Swing out sectional wall mount 19" rack.
- b. Lockable front cover.
- c. Sized as required for equipment.
- d. Include Surge Suppression type power strips as required.
- e. Manufacturer: Lowell LWR Series or equivalent.

B. REMOTE CONTROL PANELS (C2, C3, and CD)

1. Touch-screen interface module with custom graphics tailored to specific project and rotary knob.
2. PoE connection to processors.
3. 1-gang rough-in with Black faceplate.
4. Manufacturer: Biamp Apprimo TEC-X 1000

2.4 PERIPHERAL I/O

A. Mic (M1)

1. Single-Gang Stainless Steel Decora device.
2. One XLR Mic Input
3. Manufacturer: RDL #DS-XLR3F

B. Mic (M2)

1. Single-Gang Stainless Steel Decora device.
2. Two XLR Mic Inputs
3. Manufacturer: RDL #DS-XLR2F

C. Aux (A1)

1. Single-Gang Stainless Steel Decora device.
2. One 3.5 mm Audio line input.
3. One XLR Mic Input
4. Manufacturer: RDL #DS-J3M

D. Aux (A2)

1. Single-Gang Stainless Steel Decora device.
2. One 3.5 mm Audio line input.
3. One set of RCA Inputs
4. Manufacturer: RDL #DS-CIJ3

E. Bluetooth Interface (B)

1. Local Interface
 - a. Single Gang Stainless Steel Decora device with pairing button and status indication.
 - b. Remote power from associated Format A twisted pair receiver.
 - c. RJ45 type connection.
 - d. Manufacturer: RDL #DS-BT1A

2. Receiver
 - a. Format A twisted pair receiver.
 - b. Balanced and Unbalanced Output.
 - c. Installed in the equipment cabinet.
 - d. Manufacturer: RDL #TX-TPR2A

F. Local Volume Control (V)

1. Single-gang rotary attenuator for 70V systems.
2. Integral stainless steel faceplate.
3. Manufacturer: Lowell #50LVC

2.5 SPEAKERS

A. Type A1

1. 2-way 6.5" ceiling mount speaker with integral backbox.
2. 90Hz – 20kHz frequency response.
3. 140° conical distribution.
4. 60W tapped transformer at 70V.
5. White magnetically held grille.
6. Manufacturer: Biamp Desono #DX-IC6-W.

B. Type A2

1. 2-way 4.5" ceiling mount speaker with integral backbox.
2. 85Hz – 20kHz frequency response.
3. 165° conical distribution.
4. 30W tapped transformer at 70V.
5. White magnetically held grille.
6. Manufacturer: Biamp Desono #DX-IC4-W.

C. Type B1

1. Horn type speaker with integral mounting bracket.
2. 150Hz – 15kHz frequency response.
3. 90° directional distribution.
4. 15W tapped transformer at 70V.
5. Manufacturer: TOA #CS-154.

D. Type C1

1. 2-way 12" coaxial surface mount speaker.
2. 85Hz – 20kHz frequency response.
3. 90°x60° distribution.
4. 400W tapped transformer at 70V.
5. Black color housing/grill.
6. Mounting hardware/accessories as required.
7. Manufacturer: Biamp Community #R.5-96MAX-RAL9004

E. Type C2

1. 3-way 8" coaxial surface mount speaker.
2. 80Hz – 16kHz frequency response.

3. 90°x60° distribution.
4. 200W tapped transformer at 70V.
5. Black color housing/grill.
6. Mounting hardware/accessories as required.
7. Manufacturer: Biamp Community #R.35-3896-RAL9004

F. Type C3

1. 3-way 6.5" coaxial surface mount speaker.
2. 142Hz – 20kHz frequency response.
3. 90°x60° distribution.
4. 100W tapped transformer at 70V.
5. Black color housing/grill.
6. Mounting hardware/accessories as required.
7. Manufacturer: Biamp Community #R.15-3696-RAL9004

G. Type D1

1. Self-powered column array with on board DSP.
2. Dante audio input.
3. 65Hz – 20kHz frequency response.
4. 600 Watt continuous.
5. Black color housing/grill.
6. Mounting hardware/accessories as required for wall/stack mount.
7. Manufacturer: EAW #AC6.

H. Type P1

1. 2-way 6.5" coaxial pendant hung speaker.
2. 80Hz – 20kHz frequency response.
3. 125° conical distribution.
4. 60W tapped transformer at 70V.
5. Black color housing/grill.
6. Mounting hardware/accessories as required.
7. Manufacturer: Biamp Desono #DP6-B.

I. Type P2

1. 2-way 8" coaxial pendant hung speaker.
2. 80Hz – 20kHz frequency response.
3. 115° conical distribution.
4. 120W tapped transformer at 70V.
5. Black color housing/grill.
6. Mounting hardware/accessories as required.
7. Manufacturer: Biamp Desono #DP8-B.

J. Type S1

1. Dual 18" surface mount subwoofer.
2. 32Hz – 145Hz frequency response.
3. 700W each at 70V.
4. Black color housing/grill.
5. Mounting hardware/accessories as required.
6. Manufacturer: Biamp Community #IS6-218-WR-RAL9004.

K. Type S2

1. Single 18" surface mount subwoofer.
2. 32Hz – 145Hz frequency response.
3. 700W at 70V.
4. Black color housing/grill.
5. Mounting hardware/accessories as required.
6. Manufacturer: Biamp Community #IS6-118-WR-RAL9004.

L. Type S3

1. Self-powered subwoofer with on board DSP.
2. Dante audio input.
3. 27Hz – 125Hz frequency response.
4. 1000 Watt peak.
5. Black color housing/grill.
6. Mounting hardware/accessories as required for wall mount.
7. Manufacturer: EAW #RSX18F.

2.6 SPORTS CONSOLE (QTY 3)**A. Cabinet.**

1. Portable case type standard 19" rack.
2. 4U space, 13" depth.
3. Include Surge Suppression type power strip.
4. Manufacturer: Gator #G-PRO-4U-13.

B. Program Source

1. CD/Medi Player with Bluetooth, USB, and Aux inputs.
2. 1U rack mounting.
3. Manufacturer: Tascam #CD-400U

C. Wired Microphone

1. Dynamic cardioid type with on/off switch.
2. Manufacturer: Shure SM58S.
 - a. Include Gator #GFW-MIC-0600 desktop stand.
 - b. Include two Rapco #NM1-6 mic cables.

D. Wireless Microphone

1. UHF Digital type with selectable frequencies and up to 32 channels
2. Shure SLXD4D+ series Half-rack mount receiver.
3. Shure SLXD2+/SM58 wireless handheld transmitter.

E. I/O panel

1. 1U rack panel with three XLR inputs.
2. One XLR output for connection to system "M1" inputs.

F. Processor

1. 5 input (4 mic, 1 aux) microphone mixer with master volume control.

2. Half-rack space mounting.
3. Manufacturer: Shure #SCM268.
 - a. Inputs 1, 2, 3, for I/O panel inputs.
 - b. Input 4 for wireless mic.
 - c. Aux input for Program Source.

2.7 PORTABLE INSTRUCTORS PACK (Included in Dryland Alternate).

- A. Portable wireless UF transmitter/receiver package.
- B. Double ear headset with integral rechargeable battery transmitter.
- C. Manufacturer: Samson #Airline 99m AH9.

2.8 CABLE

- A. Speaker Cable:
 1. Two wire stranded with overall jacket.
 2. Gauge as required.
- B. Microphone Cable.
 1. #22 gauge, two-wire stranded, shielded, with overall jacket.
- C. Audio network/control cable.
 1. Category Network Cable as required.
- D. Provide all patch cords as required for complete system.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store A/V system equipment in a cool, dry space prior to installation.

3.2 INSTALLATION

- A. General
 1. Install in accordance with Code, product listing, and manufacturer's instructions.
 2. Prior to any rough-in, EC, Engineer and this contractor shall meet to review shop drawings and conduit routing to verify all cabling will be within the maximum lengths required for AV system cabling.
 3. All conduit shall be installed by Division 26 contractor, based on bid documents and installation drawings produced by AV contractor. All wiring installed in minimum 1/2" conduit. Verify exact conduit requirements with AV contractor.
 4. Exercise particular care in the installation of control rough-in boxes to ensure plumb and level placement.
 5. All cabling shall be installed and terminated by AV contractor.
 6. All end devices shall be installed and terminated by AV contractor.
 7. All speakers shall be hung, aimed and supported by AV contractor.
 8. All video equipment (projectors/projector screens) shall be hung, aimed and supported by AV contractor.
 9. Clearly mark all incoming cables and wires as to origin.
- B. Special care in cable installation shall be taken to ensure that grounds do not occur because of careless terminations or damage to the jacket over the shield. Take special care to ensure that random contact of shields or adjacent cables do not occur in consoles and at junction boxes.
- C. All exposed conduits shall be painted black.

3.3 FINAL ADJUSTMENT AND EQUALIZATION

- A. When the system is completely installed and operating properly (with all spurious responses such as hum, oscillation, etc. eliminated), the system shall be adjusted for even sound pressure level coverage, and then be equalized using 1/3 octave technique.
- B. The process will also provide location and reduction of acoustic feedback and ring points utilizing 1/3 octave filter panel. This portion of the equalization process will be accomplished with equipment specifically designed for this purpose.
- C. The system energy time curve and an energy frequency curve shall be measured using Smaart or SysTune dual transfer function.
- D. Record Manuals shall include complete operational instructions, individual device circuit diagrams and a one-line diagram of the system

3.4 TESTING

- A. Prior to final inspection, verify that the system is in proper working condition. Furnish letter of verification to Engineer indicating that the system has been tested by a manufacturer's representative. List date of test and name of manufacturer's representative.

3.5 INSTRUCTIONS

- A. Manufacturer's representative shall instruct Owner in proper operation, maintenance and testing of the complete system. Indicate on letter of verification, name of Owner's representative receiving instructions.
- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.6 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 27 5313
CLOCK SYSTEMS****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Provide complete and operational G.P.S. (Global Positioning System) Wireless Clock System.

B. Description of System

1. The system shall provide wireless time throughout the facility using GPS and be synchronized with the U.S. time standard.
2. The system shall synchronize all clocks to each other without the use of hard wiring between clocks.
3. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.
4. Clocks shall automatically adjust for Daylight Saving Time.
5. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
6. The system shall incorporate a “fail-safe” design so that failure of any component shall not cause failure to the system. Upon restoration of power or repair of failed component, the system shall resume normal operation without the need to reset the system or any component thereof.
7. Clock locations shall be as indicated, and battery operated clocks shall be fully portable, capable of being relocated at any time.
8. The system must operate in accordance with a “Radio Station Authorization”, Form FCC 601-LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the owner. The owner shall be able to operate the master clock transmitter under the control of the manufacture, using manufacturer’s license, prior to transferring ownership.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Show all details, including clock size, performance and method of installation. Show brochure showing available product combination, colors and finishes of clocks.
3. Submit evidence of application for operating license or that the application has been filed prior to transferring ownership to the owner, or notify the owner of the FCC license number.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include information for operating and maintaining the system, including wiring diagrams, repair parts list, proper setting of controls, and all instructions accompanying equipment.
3. Provide multiple copies for Record Manuals.

1.3 MANUFACTURER/SUPPLIER

- A. The system specified is based on equipment as manufactured by Primex Wireless, Inc., N3211 County Road H, Lake Geneva, WI 53147 (800) 537-0464. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance, which must be met.
- B. Other acceptable manufacturers:
 - 1. BRG Precision Products, Inc., 600 N. River, Derby, KS 67037 (800) 295-0220.
 - 2. Sapling, Inc., 1633 Republic Road, Huntingdon Valley, PA 19006 (215) 322-6063.
 - 3. Being listed as an acceptable manufacturer in no way relieves obligation to provide all equipment and features in accordance with this specification.
- C. All equipment shall be NRTL-listed, and shall be furnished by one manufacturer to ensure listing/equipment compatibility.

PART 2 – PRODUCTS**2.1 CLOCK SYSTEM**

- A. Transmitter
 - 1. 1-Watt transmission.
 - 2. Internal antenna.
 - 3. 16 channels available (pre-programmed prior to shipping).
 - 4. Daylight saving time bypass switch and time zone adjustment switch.
 - 5. LCD display for time, date, and signal verification.
 - 6. Input power: 120 volt 50/60 Hz
 - 7. Output power: 9 VDC (6 ft cord).
 - 8. Shall include wall mountable transmitter rack.
 - 9. Manufacturer: Primex Wireless Model 14400 series.
- B. Receiver
 - 1. GPS roof mounted with adequate cable length (plenum rated where required) for distance between GPS unit and Transmitter.
 - 2. Antenna shall be in a waterproof case, designed for roof or outdoor mounting. Mounting bracket for attachment to structure (roof or wall) shall be included.
 - 3. Operating Range: -32° - 158° F (-30° - 70°C)
 - 4. Included with Transmitter package above.
- C. Surge Protector
 - 1. Input power: 120 volt 50/60 Hz.
 - 2. Output power: 120 volts, 500 VA, 300 Watts.
 - 3. Maintenance-free sealed Lead-Acid battery with suspended electrolyte: leakproof.
 - 4. Manufacturer: Primex Wireless Model 14196 series.
- D. Clocks (Analog)
 - 1. 12.5" diameter with durable polycarbonate frame and lens.
 - 2. Shall remember the time during changing of batteries.
 - 3. Wall mountable.
 - 4. Battery operated: Shall include two D cell Lithium batteries.

5. Color: Black housing with white face and black hour/minute hands.
6. Manufacturer: Primex Wireless Model 14155 series.

E. Clocks (Digital)

1. 4" high visible 4-digit LED display.
2. Synchronized to the wireless system.
3. Flush mount.
4. Input power: 120 volts, 50/60 Hz.
5. Color: Black housing with red LED digits
6. Manufacturer: Primex Wireless Model 14201 series.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store all Clock and Program System components in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install in accordance with Code, NRTL-listing and manufacturer's recommendations.
2. Install all components in strict accordance with manufacturer's instructions.

3.3 TESTING

- A. Prior to final inspection, verify that the clock and program system is in proper working condition. Furnish letter of verification to Engineer indicating that the system has been tested by a manufacturer's representative. List date of test and name of manufacturer's representative. Contractor responsible for test coordination and scheduling.

3.4 INSTRUCTIONS

- A. Manufacturer's representative to instruct Owner in proper operation, maintenance and testing of the complete program system. Include name of Owner's representative in letter of verification.
- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 27 5319
DISTRIBUTED ANTENNA SYSTEM****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Furnish and install a complete and operational Distributed Antenna System (DAS) as shown on Drawings.

B. Description of System

1. The system shall have the capability to simultaneously boost all Bands of 5G/4G cellular signals from the following three major cellular service providers: AT&T, T-Mobile, and Verizon.
2. The system shall incorporate separate remote mounted input antennas for each carrier to ensure maximum donor signal strength per each cellular provider. Systems utilizing a single source antenna are not acceptable.
3. The system shall actively monitor the signal strength and bandwidth, and automatically make adjustments, to equalize and maximize coverage within the facility. Passive amplification systems are not acceptable.
4. The system shall include remote web-based access for monitoring and managing.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit equipment information in accordance with Section 260500.
2. Indicate:
 - a. Mounting details.
 - b. Wiring diagrams.
 - c. Description of devices.
 - d. Floor plan layout of devices.
 - e. Connection/riser diagram for specific project involved.

B. Record Manuals

1. Provide information in accordance with Section 260500.
2. Include complete data for operation and maintenance of the system, consisting of:
 - a. Wiring diagrams.
 - b. Testing.
 - c. Maintenance.
 - d. Description of system operation.
 - e. Addition of devices.
 - f. Frequency of testing procedures.

PART 2 – PRODUCTS**2.1 MANUFACTURER/SUPPLIER**

- A. The system specified is based on Quatra Series equipment as manufactured by Nextivity. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met.
- B. Supplier providing equipment and services under this Section shall be a certified installer of the product.
- C. Acceptable Suppliers
 - 1. The Computer Store, 1100 S Broadway, Minot, ND, (701) 838-3967.
 - 2. Dakota Sound Systems, 1516 E Broadway, Bismarck, ND, (701) 222-0064
 - 3. Innova Integrated Solutions, 1800 22nd Ave. SW, Minot, ND, (701) 837-0131.
 - 4. NewVison, 3320 Hamilton St. Unit 5, Bismarck, ND 58503 (701) 222-8888.

2.2 MAIN UNIT (MU)

- A. Wall mounted head end module for connecting donor antennas, interior distribution antennas, and network access.
 - 1. 3 Donor inputs.
 - 2. Supports maximum of 4 distribution antennas.
- B. Compatible with cellular carrier frequency Bands 2,4,5,12,13, and 25.
- C. 4G and 5G technology.
- D. N-Female 50 Ohm connectors.
- E. Up to 100 dB gain.
- F. 4' Power cord.
- G. Manufacturer: Nextivity #G43-BBBE or Willson #4330

2.3 ANTENNAS

- A. Donor (Exterior)
 - 1. Wide Band Directional YAGI Antenna tuned for cellular carrier frequencies.
 - 2. UV stabilized weather resistant housing.
 - 3. N-Female 50 Ohm connectors.
 - 4. Exterior mast mount.
 - 5. Manufacturer: Nextivity #V32-V32-201
 - 6. Qty of Three. One per cellular service provider.
- B. Interior
 - 1. Wide Band omni directional dome Antenna tuned for cellular carrier frequencies.
 - 2. Multiple carrier (MIMO) capability.
 - 3. N-Female 50 Ohm connectors.
 - 4. Manufacturer: Nextivity #A11-H43-301.
 - 5. Qty as indicated on the drawings.

2.4 CABLE**A. Antenna Cable**

1. 50 Ohm 1/2 inch Helix Cable.
2. Foam dielectric with copper corrugated shield and polyolefin jacket (Plenum Rated).
3. N-Male connectors.
4. Manufacturer: Commscope #LDF4RK-50A or equivalent.

B. Cable Management:

1. Six inch die-cast aluminum distribution rings: Manufacturer: Allen Tel #GB13C or equivalent.
2. Velcro cable-ties: Manufacturer: Panduit HLX series or equivalent.
3. Bridle rings: Manufacturer: B-Line BR series or equivalent.

2.5 PLYWOOD BACKING FOR SURFACE MOUNTED PANELBOARDS.

- A. 3/4" grade AD, fire-resistant, painted gray (including edges).

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store distributed antenna system components in a cool, dry space prior to installation.

3.2 INSTALLATION

- A. Securely install components where shown on Drawings.
- B. Install in accordance with Code, product listing, and manufacturer's recommendations.
- C. Contractor shall adjust and provide all other assistance required at final inspection to bring the system satisfactorily on-line.
- D. DAS Devices
1. Install donor antennas on roof where indicated on the drawings. Aim each antenna as required for maximum signal per carrier.
 2. Install DAS equipment where shown on the Drawings. Securely install components to plywood backing. Utilize Network System backing boards where applicable.
 - a. Provide Category 6 and fiber optic patch cords where DAS equipment components are installed adjacent to each other.
 3. Install interior antennas where shown on Drawings.
 - a. Provide splitters/taps where required for complete and concise installation.
- E. Antenna Cable
1. Maintain the following distances between cables, other system cables and other building systems
 - a. One (1) foot from fluorescent lights.
 - b. Four (4) feet from motors and transformers.
 - c. Three (3) feet from hot water piping or other mechanical equipment.
 - d. One (1) foot from electrical conduits, other systems cables or other electrical equipment.
 2. Provide raceway system where concealed in walls, in mechanical rooms and rooms without accessible ceilings.
 3. Route open air cables parallel or perpendicular to building construction.

4. Support cables with bridle rings, maximum 6'-0" on center.
5. Bundle multiple cable runs together with velcro cable ties, maximum 3'-0" on center.
6. Minimum one inch bending radius.
7. All cable runs shall be continuous, NO SPLICING.

3.3 TESTING REQUIREMENTS

- A. Testing of the system shall take place after substantial completion of the building.
- B. Utilize Signal Meter to ensure a signal greater than -90 dBm is provided throughout the building for every band and/or channel under the Channel Power option. Provide dBm readings for the following:
 1. Exterior antenna location.
 2. 30' to 40' O.C. in grid-like pattern for the entire interior of the building. In buildings with multiple floors, take readings from each floor.
- C. Record dBm signals on a clean set of plans at each location where a reading was taken, similar to As-Built Drawings in Section 260500, 1.4D. Submit at project completion with referenced As-Built Drawings.
- D. Prior to final inspection, verify that the system is installed in accordance with manufacturer's standards, and in proper working condition. Furnish letter of verification to Engineer indicating that the system has been tested by a manufacturer's representative and is found to be complete and functional. List date of test and name of manufacturer's representative.

3.4 INSTRUCTIONS

- A. Upon startup completion, the Owner shall be provided with a fully comprehensive training of the DAS system from a Manufacturer's representative that has complete knowledge of the of the system.
- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

- A. Clean and vacuum interior to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

SECTION 28 0500
DIVISION 28 GENERAL PROVISIONS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. The provisions and requirements of Section 260500 shall be applicable to Division 28.
- B. All Division 28 work shall be included under the Division 26 contract.
- C. The Contractor shall take special note that any conflicts between the Contractor and any Division 28 subcontractors shall not become an issue of the Engineer or Owner. It shall be the Contractor's responsibility to coordinate with the Division 28 subcontractor/s to determine where their work leaves off and where the subcontractor's work begins. The Contractor shall be responsible for all specified work including the operations of work under Division 28.

END OF SECTION

**SECTION 28 1000
CONTROLLED ACCESS SYSTEM****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Furnish and install a complete controlled access system. Include software licenses, proximity readers, door sensors, power supplies, control panels, cabling and other such products, equipment and wiring normally required for a complete and operational system.
2. All work in conjunction with this installation shall meet the provisions of the National Electrical Code and any other applicable codes.

B. Description of System

1. System to operate as follows:
 - a. Control door locks at locations indicated on drawings. Review hardware sets to determine door control type (electric strike, latch retraction, etc).
 - b. Provide access through doors via proximity card readers, mobile devices, or via request to exit sensors.
 - c. Monitor door positions.
 - d. Log all activities and provide override functions of system.
 - e. Provide paging to owner designated representative upon trouble alarm.

1.2 SUBMITTALS**A. Shop Drawings**

1. Provide information in accordance with Section 260500.
2. Indicate:
 - a. Mounting details.
 - b. Cabinet dimensions.
 - c. Wiring diagrams.
 - d. Description of devices.
 - e. Floor plan layout of devices.
 - f. Connection/riser diagram for specific project involved.

B. Manual

1. Provide information in accordance with Section 260500.
2. Include complete data for operation and maintenance of the system, consisting of:
 - a. Wiring diagrams.
 - b. Testing.
 - c. Maintenance.
 - d. Description of system operation.
 - e. Addition of devices.
 - f. Frequency of testing procedures.
3. Provide three copies, one to remain in control panel, other copies for Record Manuals.

PART 2 – PRODUCTS**2.1 MANUFACTURER/SUPPLIER**

- A. The system specified is based on equipment as manufactured by Mercury Access Control Systems and Altronix Power Supplies. All references to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met.
- B. Acceptable suppliers:
 - 1. Computer Store, 1100 S Broadway, Minot, ND, (701) 838-3967.
 - 2. Electro Watchman, Inc., 4715 19th St SE, Mandan, ND, (701) 258-6169.
 - 3. Energy Tech Systems, Inc., 1422 E Broadway Ave, Bismarck, ND, (701) 222-2999.
 - 4. Innova Integrated Systems, 1400 20th St SW, #3 Minot, ND, (701) 572-2828.
 - 5. NewVision, 3320 Hamilton St. #5 Bismarck, ND, (701) 222-8888.
 - 6. Installers not listed above and wishing to quote shall refer to Specification 260500-1.4 for approval procedure. No consideration shall be given to any installer not pre-approved.
 - 7. It is the intent that the same supplier be used for this section and Section 282000 Surveillance System equipment. The Electrical Contractor shall use the same approved vendor for this section and Section 282000 equipment.

2.2 CENTRAL SYSTEM

- A. Access Control Software
 - 1. Role based grouping.
 - 2. Programable incident reporting.
 - 3. Computer generated graphic overlay of building system to indicate location of troubles alarms.
 - 4. Remote access via desktop or mobile.
 - 5. The software version shall accommodate multiple sites
 - 6. Manufacturer: Genetec or LenelS2
 - 7. The access control software shall be an integrated part of the Video Management Software. See Specification 282000.
 - 8. Include 3 year software maintenance agreement.
- B. Server
 - 1. Software shall reside on Surveillance System Server. See Specification 282000.
- C. Access Control Panel (ACP)
 - 1. Each 8-door control panel shall include all Mercury component cards and the associated electric strike power supply equipment in a single Altronix Trove series wall mount enclosure.
 - a. Control System components
 - 1) Eight door controller.
 - 2) 16 aux inputs, 8 aux outputs.
 - 3) Ethernet option for Netcom and CIM.
 - 4) Low voltage power supply.
 - 5) Integral battery backup.
 - 6) Mercury MP series controllers or approved equal.
 - b. Electric strike power supply.
 - 1) 24VDC, 10 amp continuous output.

- 2) Eight output individually PTC protected non power-limited output terminals as required by specific system topography.
- 3) Integral battery backup with low power shut down.
- 4) Capable of individually selectable fire alarm interface.
- 5) Altronix #eFlow NAD Series.

c. Equivalent system by LifeSaftey Power.

2. Quantity of 8-door control panels as required to accommodate the number of controlled doors shown on the drawings. All control panels shall be 8-door minimum.

D. Proximity Readers

1. Indoor/Outdoor IP65 rated.
2. Universal proximity and mobile credential compatibility.
3. Wiegand output.
4. Transmitting frequencies: 125 kHz, 13.56 MHz, and 2.4 GHz (Bluetooth).
5. Supply Voltage Range 5/16 VDC.
 - a. Standard Type
 - 1) 1.4-4.0" read range for 125kHz.
 - 2) Single-Gang rough-in mounting.
 - 3) Manufacturer: HID Signo Model 40, WaveLynx Model AX-20 or approved equal.
 - b. Mullion Type
 - 1) 1.4-4.0" read range for 125kHz.
 - 2) Surface mount design
 - 3) Manufacturer: HID Signo Model 20, WaveLynx Model AX-10 or approved equal.

E. Fobs

1. Pre-programmed key fob style.
2. 32k bit proximity technology.
3. Passive, no battery design.
4. Quantity: 50.
5. Manufacturer: HID #3254 iClass SE Key II.

F. Cards

1. Pre-programmed Key Card Style.
2. 32k bit proximity technology.
3. Photo ID Compatible.
4. Ability to be used with a strap and clip as a photo ID badge.
5. Passive, no battery design.
6. Quantity: 200.
7. Manufacturer: HID iClass SE Model #3104.

G. Direct-To-Card Printer

1. Single sided printer compatible with iClass cards.
2. Include one complete set of replacement ribbon cartridges.
3. Manufacturer: HID Fargo DTC4250e.
4. ID Camera
 - a. 1080p Webcam with mini tripod.

H. Electric Door Strikes.

1. 24 Volt DC.
2. Supplied and installed by others. Coordinate with door hardware shop drawings for all specific power and rough-in requirements.

I. Motorized Electric Latch (panic device)

1. 24 Volt DC.
2. Low Power Version
 - a. 1.0 Amp inrush (0.5 sec)
 - b. 0.15 Amp holding.
3. Power transfer hardware.
4. Supplied and installed by others.

J. Door Sensors

1. Man-Door Type
 - a. Flush-mount type suitable for steel or wood doors.
 - b. Suitable for supervised inputs.
 - c. Manufacturer: Interlogix Model #1078 Series or equivalent.
2. Overhead-Door Type
 - a. Surface-mount type with 3' armored cable lead.
 - b. Suitable for supervised inputs.
 - c. Include mounting bracket suitable for application.
 - d. Manufacturer: Interlogix Model #2500 Series or equivalent.

K. Request to Exit Sensor

1. Dual technology wall or ceiling mount motion sensor with adjustable coverage.
2. DPDT contact to shunt door position sensor.
3. Low Voltage (12 – 30 VAC/VDC)
4. Interlogix Model #RCR-REX or approved equal

L. Cabling

1. Card Reader Cable.
 - a. 6 conductor, 22 AWG, shielded.
 - b. Plenum rated.
 - c. 500' length limit.
2. Electric Lock Cable.
 - a. 4 conductor, 18 AWG.
 - b. Plenum rated.
 - c. 500' length limit.
3. Door Sensor Cable
 - a. 2 conductor, 22 AWG.
 - b. Plenum rated.
 - c. 500' length limit.
4. REX Cable
 - a. 4 conductor, 22 AWG.
 - b. Plenum Rated
 - c. 500' length limit.
5. Composite Cable incorporating cables 1 through 4 above acceptable.
6. Network Cable

- a. Cat 6. See Specification 271500 for details

PART 3 – EXECUTION

3.1 STORAGE

- A. Store access system components in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install in accordance with Code, NRTL-listing and manufacturer's recommendations.
2. Wiring to comply with all National, State and Local Codes.
3. Locate devices as generally shown on Drawings and as indicated on installation instructions.
4. Provide conduit where cables are concealed in walls, in mechanical rooms, and in rooms without ceilings.

B. Server

1. Install Access Control Server in data rack adjacent to ACP's or where shown on the drawings.

C. Proximity Readers

1. Standard type to be installed on solid walls. Use mullion type on any curtain wall systems or controlled doors with glass sidelights. Coordinate installation of any mullion style readers with supplier of frame system.
2. Where installed on masonry walls, readers shall be installed such that the top of the reader is even with block coursing.
3. Coordinate all access control rough-in locations with actual site conditions and notify Engineer of any changes or deviations from plan prior to rough-in.

3.3 TESTS

- A. Furnish a letter of verification to Engineer indicating that the system has been tested by manufacturer's representative and is found to be complete and functional. List date of test and name of manufacturer's representative. Testing to include a functional test of all devices and verification of proper supervision for all devices. Notify Owner and Engineer one week in advance of scheduled tests.

3.4 INSTRUCTIONS

- A. Manufacturer's representative shall instruct Owner in proper operation, maintenance and testing of the complete alarm and detection system. Indicate on letter of verification, name of Owner's representative receiving instructions.
- B. Record instructions and include with manual in accordance with Section 260500.

3.5 CLEANING

- A. **Clean and vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 28 2000
SURVEILLANCE SYSTEM****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Furnish and install a complete and operational surveillance system. The system shall be an IP-based system with the ability to view and record IP cameras via Operator Workstations connected to the IP-based local area network (LAN). Video shall be in H.265 format and connected to the LAN.
2. Include:
 - a. IP cameras, camera lenses, camera housings, and mounting hardware.
 - b. Camera power supplies (where specified).
 - c. An independent video LAN, including but not limited to: servers, network video recorders, POE network switches and all patchcords.
 - d. Client/user meetings to appropriately configure and program the software based upon the client's needs.
3. Equipment shall conform to the requirements of FCC and EIA rules and regulations covering television equipment. All work in conjunction with this installation shall meet the provisions of the National Electrical Code and any other applicable codes.
4. Provide all system hardware and software licenses required for complete and operational system. These shall include as a minimum server licensing, database licensing, client licensing (including cameras if applicable), application licensing, etc. This shall not include licensing required for new devices added after the time of final contract acceptance or added outside of this project. All software shall be the latest compatible version at time of commissioning. Software maintenance and licensing fees for equipment and software installed and operational at the time of commissioning shall not require additional service or maintenance fees to maintain the system in an operational state, until such a time that the system is modified with new equipment or additional equipment.

B. Work Not Included

1. Network cable installation between cameras and termination racks shall be provided under Section 271513 Network Systems Cabling. Surveillance system installer shall coordinate exact cable installation requirements with cabling installer and Owner's IT representative.
 - a. If alternative cabling is required for any specific cameras, this section supplier shall coordinate with Section 271513 installer to provide required cabling, or this section contractor shall provide the required cabling. All costs shall be included in bid price.
2. For multiple rack installations, fiber optic backbone cabling shall be provided under Section 271523 Fiber Optic Cabling. Surveillance system installer shall coordinate strand requirements with Owner's IT representative.

C. Description of System

1. The surveillance cameras shall provide for the monitoring of:
 - a. Interior areas – as shown on Drawings.
 - b. Exterior of the building – as shown on Drawings.

2. The LAN shall be SNMP-managed, Gigabit, Ethernet network consisting of: Managed devices (including but not limited to: PoE network switches, servers, workstations, etc.), an Agent (software which runs on managed devices), and a network management system (NMS – software which runs on the manager). All network-attached devices shall support SNMP (Simple Network Management Protocol) and be monitored for conditions that warrant administrative attention. The new Surveillance System network shall be a physically isolated network, carrying only traffic related to the Surveillance System. A Layer 2 egress point will be identified to facilitate access as required to the Owner's data network. The Contractor shall use IP address space as provided by the Owner (the Owner will furnish a range of IP addresses to be used only for devices connected to the Surveillance System network).

1.2 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.
2. Indicate mounting details, lens type, power requirements, connection diagrams (system and internals), and description of system functions.
3. Floor plan layout of surveillance system indicating location of cameras, camera names/numbers, and data rack termination mapping. Upon request, the Engineer will furnish AutoCAD files of the floor plan. Submit one copy to Engineer for approval. Upon receipt of Engineer's approval, shop drawings to be used for system rough-in and installation. Provide one hard copy for Contractor use at the project site. Use approved shop drawings for Record Drawing/Manual submittal at project closeout (redlined to indicate actual conditions of installation).

B. Manuals

1. Submit information in accordance with Section 260500.
2. Include manufacturer's data for adjustment, operation and maintenance of equipment and name of service organization.
3. Provide multiple copies, one to remain in equipment cabinet, other copies for manuals.

PART 2 – PRODUCTS

2.1 MANUFACTURER/SUPPLIER

- A. The system specified is based on equipment as manufactured by Hanwha Techwin, Avigilon, and Axis. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met.
- B. Contractors/Subcontractors performing Section 282300 work shall be certified for installation of specific equipment by the equipment manufacturer.
- C. Acceptable installers:
 1. Computer Store, 1100 S Broadway, Minot, ND, (701) 838-3967.
 2. Electro Watchman, Inc., 4715 19th St SE, Mandan, ND, (701) 258-6169.
 3. Energy Tech Systems, Inc., 1422 E Broadway Ave, Bismarck, ND, (701) 222-2999.
 4. Innova Integrated Systems, 1400 20th St SW, #3 Minot, ND, (701) 572-2828.
 5. NewVision, 3320 Hamilton St. #5 Bismarck, ND, (701) 222-8888.
 6. Wheeler Construction, 1720 South Broadway, Minot, ND, 58701, (701) 852-5584.
 7. Installers not listed above and wishing to quote shall refer to Specification 260500-1.4 for approval procedure. No consideration shall be given to any installer not pre-approved.

8. It is the intent that the same supplier be used for this section and Section 281000 Access Control System equipment. The Electrical Contractor shall use the same approved vendor for this section and Section 281000 equipment.

2.2 CAMERAS

A. General Requirements:

1. All cameras shall be PoE network cameras connected directly to the IP network, and shall be remotely viewed, controlled, and recorded through the video management and recording software.
2. All cameras shall utilize either H.264 or H.265 Video Compression Format.
3. All cameras will be vandal resistant and incorporate motion detection technologies.
4. All cameras shall be provided with lenses suitable for the desired camera views. Fixed lenses shall be varifocal type. Cameras monitoring specific doors shall have lenses adequately adjusted to identify the individual at the door. Cameras monitoring outdoor activity, long corridors, and large indoor areas shall have lenses adequately adjusted to identify the nature of the activity in the area.
5. All outdoor camera enclosures shall be IP 66 rated (Ingress protection classification) and be equipped with a heater capable of operating in the temperature range of -30°C to 55°C (-22°F to 131°F).

B. Type A

1. 8MP X 4 channel 360° multi-sensor type with motion detection and outdoor rated (IP66) housing.
2. Day/Night (ICR), 120dB Wide Dynamic Range 15fps at full resolution.
3. Axis Model #P3738-PLE
 - a. Include ceiling/recessed mount.
 - b. OR include pole mount as keynoted.
 - c. OR include corner mount as keynoted.
 - d. OR include pendant mount as keynoted.
4. Hanwha Model #PNM-C32083RVQ
 - a. Include in-ceiling/recessed mount, or equivalent mounts as noted by the product above.

C. Type B

1. 5/6MP bullet type with motion detection and outdoor rated (IP66) housing.
2. Day/Night (ICR), 120dB Wide Dynamic Range, 20fps at full resolution.
3. Axis Model #P1487-LE
 - a. Include ceiling/wall mount.
4. Hanwha Model #XNO-C8083R.
 - a. Include ceiling/wall mount.

D. Type C

1. 13MP panoramic stye 180° multi-sensor type with motion detection and handover capability.
2. Day/Night (ICR), 120dB Wide Dynamic Range 30fps at full resolution.
3. Vertical mount directly to rough-in box.
4. Axis Model #P3818-PVE
5. Hanwha Model #PNM-A13022RV.
 - a. Include outdoor weather cap at exterior locations.

E. Type D

1. 4MP indoor/outdoor dome type with motion detection and handover capability.
2. 150dB Wide Dynamic Range, 50fps at full resolution.
3. Video analytics to include loitering, enter/exit, counting, face detection, and heatmap.
4. Axis Model #P3277-LVE
 - a. Include recessed ceiling mount.
5. Hanwha Model #XNV-C7083R.
 - a. Include in-ceiling mount backbox.

- F. Type F
 1. 12MP Fisheye type with motion detection and handover capability.
 2. 120dB Wide Dynamic Range, 30fps at full resolution.
 3. Axis Model #M4338-PLVE
 - a. Include recessed ceiling mount.
 - b. OR include pendant mount as keynoted.
 - c. OR include surface/back box mount as keynoted.
 4. Hanwha Model #XNF-A9014RV
 - a. Include ceiling mount or equivalent mounts as noted by the product above.
- G. Type G
 1. 4MP X 4 channel 360° multi-sensor type with motion detection and handover capability.
 2. Day/Night (ICR), 120dB Wide Dynamic Range 15fps at full resolution.
 3. Axis Model #P3737-PLE
 - a. Include ceiling/recessed mount.
 - b. OR include pendant mount as keynoted.
 4. Hanwha Model #PNM-C16013RVQ
 - a. Include in-ceiling/recessed mount, or equivalent mounts as noted by the product above.

2.3 CAMERA POWER SUPPLY

- A. All cameras to be PoE compatible.
- B. Camera(s) may connect to the nearest data rack shown on the drawings. Contractor is responsible for providing PoE switch in any data rack used for camera connections.
- C. When multiple switches are utilized, the Layer 2 managed network shall be configured with edge-core topography. Cameras shall be terminated to edge switches with minimum 56 Gb/s capacity and at least one core switch with minimum 176 Gb/s capacity shall tie all edge switches to the servers and storage devices.

2.4 VIDEO MANAGEMENT SOFTWARE

- A. The video management software shall control the recording/storage services and operator client services utilizing real-time database synchronization by operating on a free database technology such as SQLite (included with installation). It shall also incorporate the Access Control Software to fully integrate users, alarms, etc. Users can connect to any system server to view live stream or playback and manage the entire system.
 1. It shall support calendar search functions and advanced video analytics incorporated in the specified cameras.
 2. It shall incorporate automatic camera failover to ensure limited recording loss.
 3. The system shall be comprised of five applications
 - a. Cloud app for simple remote connectivity, viewing, and management.
 - b. Server app for managing system users, devices, and data.
 - c. Desktop app for client connection or stand-alone media player.
 - d. Mobile app for iOS and Android connection allowing view, search, and camera control.
 - e. Access Control app: See Specification 281000 for access control system requirements.
 4. Software licensing shall be on a per device basis (1 license per camera or I/O device) with no tier licensing for additional features or capabilities.
 - a. Include 5 year software maintenance agreement if required.
 5. Manufacturer: Avigilon, Genetec, or LenelS2.

2.5 NETWORK VIDEO RECORDER (NVR)

- A. Network video recorder with video management software preloaded on recorder utilizing H.264 or H.265 Video Compression Format.
- B. Provide 30-day data recording capability at continuous high activity rate, at each camera type's rated recording rate.
 - 1. Storage configuration shall be RAID 6
- C. Supports up to 128 camera channels per NVR.
- D. Full remote client via internet connection.
- E. Redundant power supply.
- F. Standard 19" rack mount chassis.
- G. Manufacturer: Same as camera manufacturer, or approved equal.
- H. PoE/PoE+ Network Switches
 - 1. Where multiple network switches are required, an edge/core star topography shall be configured. The server and storage devices, as well as the client network port shall be connected directly to the core switch. All edge switches shall be connected via fiber optic cable to the core switch. No "daisy chaining" of edge switches.
 - 2. Core Switch: Cisco Catalyst 9300 Series or equivalent with SFP+ network modules as required.
 - 3. Edge Switches: Cisco Catalyst 9200 Series or equivalent 24 or 48 port switch with 10 Gigabit SFP+ uplink.

2.6 VIDEO MONITOR

- A. 22" high contrast wide screen monitor.
- B. Rack mount option.
- C. 1920 x 1080 resolution.
- D. Manufacturer: Camera manufacturer or equivalent.

2.7 EQUIPMENT CABINET

- A. Install equipment in Specification 271513 data rack.

2.8 UPS SYSTEM (UNINTERRUPTED POWER SOURCE)

- A. An uninterruptible power supply (UPS) shall provide backup power for a minimum period of 1 hour under 100% load. The UPS shall be "on line" type with power conditioning in either normal or backup mode.
- B. Rack mount version.
- C. Manufacturer: APC Smart-UPS SRT Series, CyberPower OL Series, or Powerware 5P series.

2.9 CABLE/CONNECTORS

- A. Provide Category 6 and fiber optic patchcords as required to connect surveillance system equipment to the building network cabling.
 - 1. Refer to Section 271513 Network Cabling and Section 271523 Fiber Optic Cabling for requirements.

PART 3 – EXECUTION**3.1 STORAGE**

- A. Prior to installation, store surveillance system equipment in dry area, place protected from the elements, with temperature maintained above freezing.

3.2 INSTALLATION

- A. Securely install components where shown on Drawings.
- B. Exterior units shall be mounted for optimum coverage and to protect camera from accidental blows and vandalism. Provide all required mounting hardware.
- C. Contractor shall coordinate with Owner and Engineer to adjust, aim, change lenses and provide all other assistance required at final inspection to bring the system satisfactorily on-line.
- D. Install in accordance with code, NRTL listing, and manufacturer's recommendations and instructions.

3.3 STARTUP

- A. Prior to final inspection, verify that the surveillance system is in proper working condition. Furnish a letter of verification to Engineer indicating that the system has been tested by manufacturer's representative and is found to be complete and functional. List date of test and name of manufacturer's representative.

3.4 INSTRUCTIONS

- A. Upon startup completion, the Owner shall be provided with a fully comprehensive training of the surveillance system from a Manufacturer's representative that has complete knowledge of the advanced search features and analytics features of the system. This representative shall be able to effectively demonstrate the advanced search and analytic features; and assist the Owner with implementation of these features.
- B. Instructions shall consist of a minimum of three separate periods, lasting no more than 2 hours each, scheduled at Owner's convenience and completed within the following timeframe: one session at substantial completion; one session approximately 30 days after substantial completion; one approximately 60 days after substantial completion.
 - 1. Instruction periods shall progress from basic operations to advance functions tailored to Owner's comprehension of the system.
 - 2. Record instructions and include with Record Manuals in accordance with Section 260500
- C. One additional follow up instruction period shall be implemented prior to the 1-year warranty expiration.

- D. Perform any required adjustments and maintenance items that become apparent during these instruction periods, including software updates.

3.5 **CLEANING**

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 28 4611
FIRE ALARM AND DETECTION****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Furnish and install a complete addressable fire alarm and detection system in accordance with NFPA 72 and this specification.

B. Work not included

1. Where required, the Owner shall be responsible for:
 - a. Line lease or service fees associated with signal transmission (alarm, supervisor, and trouble) to a remote central station.
 - b. Any proprietary interface equipment not specified herein and required by the Owner's monitoring service.

C. Description of System

1. General: Provide a complete, non-coded, addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the Drawings and as specified herein.
2. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on site programming to accommodate system expansion and facilitate changes in operation. All software shall be stored in a non-volatile programmable memory within the fire alarm control panel (FACP). Loss of primary and secondary power shall not erase the instruction stored in memory.
3. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. Separate alarm, supervisory and trouble logs shall be provided.
4. Wiring/Signal Transmission
 - a. Transmission shall be addressable signal transmission, dedicated to fire alarm service only.
 - b. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the fire alarm control panel. Provide a distinctive indicating audible tone and alphanumeric annunciation.
 - c. System connections for initiating, signaling line circuits and notification appliance circuits shall be Class A or Class B as described in Part 3 of this specification.
5. Analog Smoke Detectors
 - a. Monitoring: The FACP shall individually monitor detectors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The FACP shall determine the condition of each detector by comparing the detector value to the stored values.
 - b. Environmental Compensation: The FACP shall maintain a moving average of the detector's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 - c. Programmable Sensitivity: Smoke detectors shall have multiple sensitivity levels, programmed and monitored from the FACP.
 - d. The FACP shall automatically indicate when an individual detector needs cleaning.
 - e. The FACP shall continuously perform an automatic self-test on each detector, which will check detector electronics and ensure the accuracy of the values being transmitted. Any detector that fails this test shall indicate a trouble condition.
6. Analog Heat Detectors
 - a. Monitoring: The FACP shall individually monitor detectors for alarm condition and shall individually adjust for fixed temperature sensing and rate-of-rise sensing. The FACP shall determine the condition of each detector by comparing the detector value to the stored values.

- b. Programmable Sensitivity: Heat detectors shall have rate-of-rise temperature detection values selectable at the FACP for either 15° F or 20° F per minute. Fixed temperature sensing is independent of rate-of-rise sensing and shall operate at either 135° F or 155° F.
 - c. The FACP shall continuously perform an automatic self-test on each detector, which will check detector electronics and ensure the accuracy of the values being transmitted. Any detector that fails this test shall indicate a trouble condition.
7. Power Requirements
- a. The FACP and each required expansion panel shall receive 120-volt AC power via a dedicated 20-ampere circuit breaker from the nearest panelboard. The incoming power to each panel shall be supervised so that any power failure will be indicated at the FACP and sound a trouble signal. The primary power branch circuit supplying fire alarm equipment shall supply no other loads. The circuit breaker:
 - 1) Location shall be permanently identified at the corresponding control unit.
 - 2) Shall have a listed circuit breaker locking device installed.
 - 3) Shall have a red marking which shall not damage the overcurrent protective device or obscure the manufacturer's markings.
 - 4) Shall be permanently identified as to its purpose: "FIRE ALARM" for fire alarm systems, "EMERGENCY COMMUNICATIONS" for emergency communications systems, and "FIRE ALARM/ECS" for combination fire alarm and emergency communications systems.
 - b. The FACP shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic. System batteries shall be supervised so that a low battery condition or disconnection of the battery shall be indicated at the control panel.
 - c. All circuits requiring system-operating power shall be 24-volt DC and shall be individually fused at the control panel.
 - d. The system shall support 100% of the addressable devices in alarm operation at the same time, under both primary (AC) and secondary (battery) power conditions.
8. Fire Sprinkler Monitoring
- a. Water Flow: Activation of a water flow switch shall initiate a general alarm operation.
 - b. Valve Supervisory Switch (Tamper Switch): The activation of any valve supervisory switch shall activate system supervisory operations.
 - c. Activation of either a water flow switch or valve supervisory switch shall distinctly report which device is in alarm at the FACP and any required remote annunciator(s).

1.2 ONE-WAY VOICE COMMUNICATION

- A. The system shall incorporate one-way voice communication and tone generating capabilities.
- B. A central audio control module shall be provided for the necessary alarm message/tone generation, main and remote microphone connections, music inputs, and mixer/preamplifier circuits. Continuous supervision shall be provided along with specific information as to the type of failure, should a problem occur. Audio outputs shall have individual gain control.
- C. A hand-held, push to talk microphone shall be provided, recessed within a protective panel. The microphone shall have a frequency range of 200Hz to 4000Hz, and shall be equipped with a coiled cable. The microphone shall be supervised for disconnection. The voice communication controls shall be incorporated into the fire alarm control panel and into the remote annunciator panels.
- D. Audio power amplifiers shall be furnished with a self contained filtered 24vdc power supply, transformer, and amplifier monitor circuits. The amplifier shall provide a 25 volt RMS or 70.7 volt RMS output with a frequency response of 120Hz to 12,000Hz. Provide sufficient amplification to operate all system speakers simultaneously, plus fifty (50) percent space capacity.

- E. The speaker circuits shall be capable of supplying 25 volt RMS or 70.7 volt RMS audio power from the system amplifiers. Supervision for open, short, or ground fault conditions shall be provided. Individual and distinct trouble indications shall be provided for each. Provide minimum two circuits.
- F. Digitized tones for alarm (slow whoop) and auxiliary requirements (wail, horn, chime, etc.) shall be provided.
- G. A pre-recorded digitized voice message capability is to be provided for automatic transmission to building occupants during alarm conditions. The automatic message player shall not rely on a tape or other mechanical means of transmitting the evacuation message. A standard evacuation message shall be provided under this contract; however, the message player must be capable of transmitting custom message of up to five (5) minutes in length. A self contained speaker will provide testing of the message(s) without disturbing the occupants of the facility.
- H. A pre-recorded digitized P.N.I.S. (Positive Non-Interfering Successive) voice coding capability shall be provided for automatic transmission to building occupants during alarm conditions. A separate "voice code" shall sound throughout the facility for each zone in alarm condition.
- I. The audio alarm signal shall interrupt any gymnasium sound system such that the gymnasium sound signal is stopped, or the audio alarm signal is broadcast over the gymnasium sound system.
- J. Automatic Voice Evacuation Sequence:
 - 1. The audio alarm signal shall consist of an alarm tone for a maximum of 15 seconds followed by automatic pre-selected voice evacuation messages. At the end of each voice evacuation message, the alarm tone shall resume. The alarm tones shall sound alternately until the alarm silence switch at the fire alarm control panel has been operated.
 - 2. An audio alarm operations (speaker circuit selection and alarm tone/voice message timing variations) shall be activated by the system software so that any required future changes to the evacuation sequence can be facilitated by authorized personnel without any component rewiring.
- K. Manual Voice Paging Sequence:
 - 1. The system shall be configured to allow selective voice paging. Upon activation of any speaker manual control switch, an attention-getting beep shall sound over the speakers indicating an impending voice message will occur.
 - 2. If any speaker manual control switches are activated, the control panel operation shall be able to make announcements via the push-to-talk paging microphone over the pre-selected speakers.
 - 3. Facility for total building evacuation and paging shall be provided to allow for activation of all speakers. This shall be accomplished by the means of an "All Call" switch.

1.3 REQUIRED SYSTEM FUNCTIONS

- A. Priority of Signals: Alarm events have the highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Supervisory and Trouble events have second-level and third-level priority respectively. Events of a higher-level priority take precedence over events of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
- B. Non-interfering: The activation of an addressable device does not prevent receipt of signals from subsequent activations.
- C. Transmission to Remote Central Station: The FACP shall have the capability to automatically route alarm, supervisory, and trouble signals to a central station via Internet Protocol (IP) over the public open Internet.

- D. Types of Signaling: The FACP shall be NRTL-listed for the applicable types of signaling methods used, i.e.: Temporal Coded, Non-Coded, March Time and/or Internet Protocol.
- E. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and any required remote annunciator(s), indicating the location and type of device.
- F. General Alarm: Activation of an alarm initiating device shall include:
1. Indication of alarm condition at the FACP and any required remote annunciator(s).
 2. Identification of the device that is the source of the alarm at the FACP and any required remote annunciator(s).
 3. Operation of all audible and visual notification appliances throughout the building until silenced at the FACP and any required remote annunciator(s). Audible alarm notification shall operate steady or match existing building convention.
 4. Shutting down designated air handling equipment, and activating smoke dampers and exhaust fans as required by alarm input.
 5. Have the capability to automatically route the signal to a Remote Central Station.
 6. The control panel shall be capable of bypassing Items 4 and 5 through the use of programmable touch pads on the front of the control panel. These touch pads shall be password-protected to prevent unauthorized tampering.
 7. Record the event in the FACP historical log.
 8. Closing doors normally held open by magnetic door holders.
 9. Initiate elevator recall in accordance with ASME/ANSI A17.1, when designated fire alarm detectors are activated.
 10. Initiation of smoke control sequence.
 11. Unlocking of designated doors.
- G. Supervisory Operations: Upon activation of a supervisory device such as fire pump failure, low air pressure switch, and tamper switch, the system shall operate as follows:
1. Activate the system supervisory service audible signal and illuminate the LED at the FACP and any required remote annunciator(s).
 2. Pressing the Supervisory Acknowledge key will silence the supervisory audible signal while maintaining the supervisory LED "on" indicating off-normal condition.
 3. Record the event in the FACP historical log.
 4. Transmission of supervisory signal to Remote Central Station.
- H. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease. (Visual signals shall continue to operate.)
- I. System Reset:
1. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide the operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate, "ALARM PRESENT, SYSTEM RESET ABORTED."
 2. Should an alarm condition continue, the system will remain in an alarmed state.
- J. Drill: A manual activation (drill) switch shall be provided to initiate an alarm on the FACP.
- K. Manual Control: Manual controls shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble. The "off normal" status shall be clearly identified in plain language on the FACP alphanumeric display.

1. Manual Bypass Control: The ability to perform a manual bypass of selected automatic functions shall be provided.
 2. Circuit Enable/Disable Control: The system shall have provisions for disabling and enabling each circuit individually for maintenance or testing purposes.
- L. WalkTest: The system shall be capable of being tested by one person without returning to the control panel to reset the system after each alarm. Enabling the one-person test feature at the FACP shall activate the "One person Testing" mode of the system as follows:
1. The control panel shall automatically log each alarm and each trouble condition tested, and reset the system for the next condition to be received. Should the walktest feature be left off for a preprogrammed length of time without any activity, the system shall revert to the normal operating mode automatically.
 2. The city circuit connection and suppression release circuits shall be bypassed for the testing group.
 3. Control relay functions associated to the testing group shall be bypassed.
 4. The FACP shall indicate a trouble condition.
 5. The alarm activation of any initiating device in the testing group shall cause the audible notification appliances to sound a code to identify the device.
 6. The control panel shall automatically reset itself after signaling is complete.
 7. Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.

1.4 SUBMITTALS

A. Shop Drawings

1. Submit information in accordance with Section 260500.
2. Indicate:
 - a. Mounting details.
 - b. Cabinet dimensions.
 - c. Wiring diagrams.
 - d. Description of devices.
 - e. Floor plan layout of fire alarm system indicating location of devices, wiring between devices, and intensities of audible and visual appliances. Upon request, the Engineer will furnish AutoCAD files of the floor plan. Submit one copy to Engineer for approval. Upon receipt of Engineer's approval, provide **additional four** copies. Submit one copy to Engineer. Remaining copies for Contractor use at the project site and for Record Drawing/Manual submittal at project closeout (redlined to indicate actual conditions of installation).

B. Record Manuals

1. Provide information in accordance with Section 260500.
2. Include complete data for operation and maintenance of the system, consisting of:
 - a. Wiring diagrams.
 - b. Testing.
 - c. Maintenance.
 - d. Description of system operation.
 - e. Addition of devices.
 - f. Frequency of testing procedures.
 - g. All data referenced in NFPA 72, 7.5.
3. Provide multiple copies (including shop drawing connection/riser diagram), one to remain in control panel, other copies for Record Manuals.

1.5 MANUFACTURER/SUPPLIER

- A. The system specified is based on equipment as manufactured by Johnson Controls Fire Protection: Autocall. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance, which must be met.
- B. Other acceptable manufacturers: Edwards Systems Technology, Potter Electric Signal, or Siemens Fire Safety.
 - 1. Being listed as an acceptable manufacturer in no way relieves obligation to provide all equipment and features in accordance with this specification.
- C. All equipment shall be NRTL-listed, and shall be furnished by one manufacturer to ensure listing/equipment compatibility as required by NFPA 72.
- D. Supplier providing equipment and services under this Section shall have:
 - 1. A factory-authorized service center located in North Dakota within 250 miles of the project site. Referenced service center shall be under direct control of the Supplier, staffed by employees of the Supplier, and contain an inventory of replacement material requisite for timely maintenance. Referenced service center shall be operational for a minimum five-year period or have equivalent five-year industry experience with installation and programming prior to bid opening.
 - 2. A minimum of one employee at the above referenced service center certified by National Institute for Certification in Engineering Technologies (NICET). Certification shall be in the Fire Protection Engineering Technology field, Fire Alarm Systems sub-field, and shall be minimum Level III.
- E. Acceptable Suppliers:
 - 1. ACS, 3410 13th St NE, Minot, ND (701) 446-8840.
 - 2. Electro Watchman, Inc., 4715 19th St SE, Mandan, ND (701) 258-6169.
 - 3. Forte, 1502 Gruman Lane, Bismarck, North Dakota, (701) 963-4693.
 - 4. Nardini Fire Equipment Co. Inc., 303 20th St N, Fargo, ND (800) 950-1139.
 - 5. NewVison, 3320 Hamilton St. Unit 5, Bismarck, ND 58503 (701) 222-8888.
 - 6. SimplexGrinnell, 2821 Fiechtner Drive, Fargo, ND (800) 342-4668.
 - 7. Systems Technology, 1424 44th St N, Fargo, ND 58102 (701) 235-0558.

PART 2 – PRODUCTS**2.1 CENTRAL SYSTEM**

- A. Fire Alarm Control Panel (FACP)
 - 1. General: Comply with UL 864, “Control Panels for Fire-Protective Signaling Systems.”
 - 2. Cabinet:
 - a. Steel enclosure with lockable, hinged door for front access. Surface or flush-mount style as indicated on the Drawings.
 - b. Color: Red when surface-mounted in equipment rooms, and beige, black or gray when flush-mounted in other locations.
 - 3. The following FACP hardware shall be provided:
 - a. Power limited base panel with 120-volt AC input power.
 - b. Addressable point capacity: Size for requirements of Drawings and Specifications, minimum of 100 points expandable to 250 points, inclusive of inputs and outputs in any combination (Autocall #4017ES series).
 - c. Supports live and pre-recorded voice communication.

- d. Appropriate initiating device circuit (IDC) and notification appliance circuit (NAC) modules to support Class A or Class B circuits as described in Part 3 of this specification
- e. Alphanumeric Display and System Controls: FACP shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- f. Notification appliance circuits: Size for requirements of Drawings and Specifications, minimum of 4 required.
- g. Two form "C" auxiliary output circuits (rated 2A @ 24-volt DC, resistive), operation is programmable for trouble, alarm, supervisory or other selective control operations. Provide capability for switching up to 1/2 A @ 120-volt AC, inductive loads.
- h. Secondary (emergency) power supply including: battery(s), charger and automatic transfer switch. Battery(s) shall be sealed lead-acid type.
- i. An IP communicator to automatically route the alarm signals to a Remote Central Station.
 - 1) Designed to monitor the status of the FACP and report to a Remote Central Station as follows:
 - a) Alarms.
 - b) Troubles.
 - c) Supervisory conditions.
 - 2) The transmission path shall be supervised at an interval of 60 minutes or less.
 - 3) Module Types:
 - a) Direct connect IP communication module.
 - b) IP dialer capture module to convert Digital Alarm Communicator information to IP protocol.
- j. Supervised serial communication circuit for control and monitoring of remotely located LCD annunciator(s) and I/O panels.

B. Expansion Panels

- 1. NAC Addressable Controller
 - a. Stand-alone panel providing power and communications interface for addressable notification appliances with:
 - 1) Three isolated output channels for addressable notification appliance control.
 - 2) Channels that are Signaling Line Circuits (SLC's), each rated at 2-1/2 A and for up to 63 addressable notification appliances (up to 189 per controller).
 - 3) Individual supervision of each appliance allowing Class B wiring to be branch connected and "T" tapped.
 - 4) Comply with UL 864.
 - b. Input power: 120-volt AC.
- 2. NAC Extender
 - a. Stand-alone panel capable of:
 - 1) Powering a minimum of four non-addressable notification appliance circuits. Each circuit rated 2 A @ 24-volt DC.
 - 2) Controlling non-addressable notification appliances.
 - b. Internal power supply and battery charger capable of charging internal-mounted batteries or batteries mounted in an external cabinet where required.
 - c. Connected to the FACP via addressable communications circuit. Via the communications circuit each output notification appliance circuit can be individually controlled for general alarm or selective area notification.
 - d. Alarms from the FACP shall signal the NAC extender panel to activate. The panel shall monitor itself and each of its NACs for trouble conditions and shall report trouble conditions to the FACP.
 - e. Input power: 120-volt AC.

C. Alarm Initiating Devices

- 1. Manual fire alarm station:

- a. "Address capable"
 - b. Non-coded single action.
 - c. Provide two spare stations.
 2. Automatic area smoke detection station:
 - a. "Address" capable.
 - b. Combination photoelectric smoke and fixed heat plug-in "head" unit which mounts to a twist-lock base.
 - c. Individual station sensitivity levels are selected and monitored at the control panel.
 - d. Self-restoring.
 - e. White or Black color.
 - 1) Verify color for each area/room with architect and engineer.
 - f. Comply with UL 268.
 - g. Provide three spare stations.
 3. Automatic duct smoke detection station:
 - a. "Address" capable.
 - b. Automatic photoelectric smoke detection station with associated duct housing and sampling tubes as required.
 - c. Refer to Motor and Equipment Schedule for equipment requiring duct detection.
 4. Automatic area heat detection station:
 - a. "Address" capable.
 - b. Combination rate-of-rise and fixed temperature rate compensated sensing plug-in "head" unit, which mounts to a twist-lock base.
 - c. Individual station rate-of-rise temperature levels are selected and monitored at the control panel. Fixed temperature level is independent of rate-of-rise levels and shall operate at 135° F or 155° F. Select appropriate mode.
 - d. Locations requiring temperature ratings exceeding 155° F may include hardwired detector on an addressable base.
 - e. Self-restoring.
 - f. Low profile.
 - g. White or Black color.
 - 1) Verify color for each area/room with architect and engineer.
 - h. Provide two spare stations of each rating.
 5. Automatic Carbon Monoxide (CO) detection station:
 - a. "Address" capable.
 - b. Combination photoelectric smoke and carbon monoxide detector plug-in "head" unit which mounts to a twist-lock base.
 - c. Self-restoring.
 - d. Low profile.
 - e. White or Black color.
 - 1) Verify color for each area/room with architect and engineer.
 - f. Comply with UL 2075 and 268.
 - g. Provide one spare CO station.
- D. Alarm Notification Appliances
 1. Voice evacuation speaker appliance
 - a. Speaker connections shall be on a standard 25 Vrms or 70.7 Vrms NAC.
 - b. Following taps shall be available: .25W, .50W, 1.0W and 2.0W. At the 1.0W tap, the speaker shall have a minimum rated sound pressure level of 84 dBA at 10 feet.
 - c. The appliance shall have a frequency response of 400 to 4000 Hz for fire alarm and 125 to 12 kHz for general signaling.
 - d. Provide 4" square backbox as per manufacturer's requirements, minimum 3" deep.
 - e. Wattage rating and quantity of amplifiers as required to power all connected appliances assuming they are set at maximum power tap.
 - f. Red or White finish.
 - 1) Verify color for each area/room with architect and engineer.
 2. Visual alarm notification appliance

- a. Xenon or LED flash tube and associated lens/reflector system.
 - b. Comply with Americans With Disabilities Act (ADA).
 - c. Minimum of four (4) field selectable strobe intensity settings: 15, 30, 75 and 110 candela. All settings shall be UL 1971 listed for both wall and ceiling mount applications. Select strobe intensity for each unit as dictated by location and NFPA 72, 18.5.
 - d. "Fire" lettering on housing or lens.
 - e. Red or White finish.
 - 1) Verify color for each area/room with architect and engineer.
 - f. Comply with UL 1971.
 - g. Class A operation.
3. Where shown ganged together on Plans, combine audible and visual alarm notification appliances into one device.
 4. Manufacturer: Same as control panel.

E. Auxiliary Devices

1. Magnetic door holder:
 - a. 24 volt or match existing.
 - b. Extra low profile for use with concealed wiring.
2. Individual addressable module (IAM):
 - a. Module provides supervised, location specific addressability, to a single initiating device by monitoring normally open, dry contacts. Closure of contacts initiates an alarm or trouble signal as required by the device being monitored.
 - b. Used to provide addressable monitoring of devices such as flow or tamper switches, etc.
 - c. Powered directly from signaling line circuit. No separate power source required.
 - d. Mount in single-gang box, minimum 2-1/2" deep.
 - e. Included with flush or surface cover as required.
 - f. Provide a separate IAM for each device being monitored.
3. Individual addressable relay module (Relay IAM):
 - a. Module provides control and status tracking of a Form "C" SPDT, dry contact.
 - b. Module power and communications provided directly from the signaling line circuit.
 - c. Used to provide addressable control functions such as elevator recall, HVAC control, fan control, damper control, etc.
 - d. Mount in standard 4" square box.
 - e. Included with flush or surface cover as required.

F. Manual Shutdown

1. Manual shutdown capability included with motor starter.

G. Automatic Shutdown

1. Automatic shutdown capability for air handling equipment where required by NFPA 90A.
2. Locate fan shutdown relays remote from fire alarm control panel, controlled by integral relay in fire alarm control panel, with bypass switch.
3. Refer to Motor and Equipment Schedule for equipment requiring automatic shutdown.
4. Wiring: Two-wire parallel independent circuit to fire alarm control panel.

H. Remote Annunciator

1. Alphanumeric LCD display with the same "look and feel" as the FACP operator interface.
2. Status LED's provide system status in addition to LCD display information. Status LEDs included for:
 - a. Alarm.
 - b. System trouble
 - c. System supervisory.

- d. Alarm silenced.
 - e. Power on.
3. Should an abnormal condition be detected the appropriate LED shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions. When acknowledged, the LED shall remain on until reset.
4. Captive key switch enables following push buttons:
 - a. Alarm acknowledge.
 - b. Trouble acknowledge.
 - c. Alarm silence.
 - d. System reset.
 - e. Supervisory acknowledge
5. Touchscreen type remote annunciator incorporating the same functionality as listed shall be acceptable.
6. A hand-held, push to talk microphone shall be provided, recessed within a protective panel. The microphone shall have a frequency range of 200Hz to 4000Hz, and shall be equipped with a coiled cable. The microphone shall be supervised for disconnection.

I. Fire Sprinkler System Equipment

1. Flow switch(es) and valve supervisory switches furnished and installed by Fire Sprinkler Contractor, wired by Electrical Contractor.
2. Fire sprinkler alarm notification appliance (bell or audible-visual signaling unit) furnished by Fire Sprinkler Contractor, installed and wired by Electrical Contractor.

J. Elevator Fire Sprinkler/Power Module Switch

1. Interface with the elevator fire sprinkler/power module switch such that activation of the elevator and/or elevator equipment room fire sprinkler flow switch(es) shall disconnect the elevator power circuit via the power module shunt trip operator.
2. Interface with fire alarm voltage monitoring relay furnished with power module switch to comply with NFPA 72.
3. Provide fire alarm IAM(s) as required by elevator power module switch characteristics.
4. Refer to "Elevator Fire Sprinkler/Power Module Switch Interface" Detail on the Drawings.

PART 3 – EXECUTION

3.1 STORAGE

- A. Store fire alarm components in a cool, dry area prior to installation.

3.2 INSTALLATION

A. General

1. Install in accordance with code, product listing, and manufacturer's recommendations.
2. Wiring to comply with all national, state and local fire codes.
3. All fire alarm circuitry shall be installed in raceway unless otherwise noted. Refer to Section 260533 for acceptable raceways.
4. Conductors:
 - a. Quantity as required by manufacturer.
 - b. Signaling Line Circuits (SLC):
 - 1) Two-conductor #18 AWG, twisted pair shielded or unshielded cable as per manufacturer requirements.
 - 2) NFPA 72 Class A, "T" tapping not permitted (exceptions as per NFPA 72, 12.3.8.1 acceptable).

- c. Alarm notification appliance circuits (NAC):
 - 1) Voice Evacuation Appliances
 - a) Audible: Two-conductor #16 AWG, twisted pair shielded or unshielded cable as per manufacturer requirements.
 - b) Visual: Solid, #14 AWG minimum, size for maximum 5% voltage drop.
 - 2) NFPA 72 Class A, "T" tapping not permitted (exceptions as per NFPA 72, 12.3.8.1 acceptable).
 - 3) Audible appliances (horns) controlled separately from visual appliances.
 - 4) All visual appliances shall flash in synchronization.
 - d. Miscellaneous Circuits: (such as magnetic door holders & etc.)
 - 1) Solid, #14 AWG minimum, size for maximum 5% voltage drop.
 - e. Color Coding: Manufacturer/Supplier requirements.
 - f. Enclosed in raceway system (i.e. conduit).
 - g. To ensure proper supervision of initiating and indicating circuitry, three wires maximum per wire-nut.
- 5. Raceway Systems:
 - a. Size raceway systems and junction boxes as per NEC.
 - b. All raceway systems shall be externally identified by permanent RED paint suitable for the purpose to easily distinguish from other electrical raceway systems. Items shall be painted prior to installation. In addition to field painted conduit, factory painted conduit as manufactured by Allied Tube & Conduit or equivalent is acceptable.
 - 1) Exceptions: Raceway color coding shall not apply to the following areas:
 - a) Raceway systems embedded directly in earth or concrete.
 - b) Surface mounted raceways systems in finished spaces where all raceways are to be painted to match adjacent surfaces.
 - c. Route outgoing and return Class A circuits in separate conduits (exceptions as per NFPA 72, 12.3.8.1 acceptable).
 - d. Multiple circuits acceptable in same raceway system.
 - 6. Terminations:
 - a. Connect all devices according to manufacturer's data.
 - b. Made on terminal strips with separate joint for each conductor.
 - c. Number identify all strips as shown in wiring diagram included with manual.
 - d. Number identify all conductors to agree with terminal strip numbering.
 - e. When required, end of line devices to be mounted on terminal strips in the FACP.
 - f. Wire-nut terminating not acceptable.
 - 7. Do not zone alarm notification appliances. Rather, route notification appliance circuits (NAC's) with signaling line circuits (SLC's). Terminate and jumper as required to maintain supervision on identified terminal strips.
 - 8. Locate devices as generally shown on Drawings and as specifically indicated on installation instructions.
 - 9. Remote fan shut-down relays to be mounted near controller or equipment.
 - 10. Where control panel is shown to be surface-mounted, provide 3/4" grade AD, fire-resistant, gray painted (including edges), plywood backing.
 - 11. Provide 1/2" conduit from fire alarm control panel to nearest network rack offering internet access. Provide a four-pair minimum Category 5e UTP data cable terminated to the IP communicator module. Ensure owner's internet access equipment complies with secondary power requirements as required by NFPA 72. If owner provided internet access is not available, provide additional dedicated IP equipment as required to obtain internet service in conformance with NFPA 72.
 - 12. Provide elevator/fire alarm interface as per Section 262822.

B. Spot-Type Detectors

- 1. Locate as generally shown on Drawings and as specifically indicated in NFPA 72 and on installation instructions.

- a. All detectors in rooms with gas fired equipment shall include CO sensor.
2. Provide protective plastic wrapping to prevent entrance of construction dust. Field-install during construction. Remove immediately prior to supplier testing. Replace protective plastic wrapping and remove day of final inspection.
3. All smoke/heat detection devices shall be located a minimum of 3' from any supply, return, or exhaust air diffusers/grills.

C. Duct Detectors

1. Installed and arranged to automatically initiate general alarm.
2. Provide at a suitable location in the return air stream prior to exhausting from building or being diluted by outside air.
3. Provide at a suitable location in main supply duct on downstream side of filters.
4. Refer to Motor and Equipment Schedule for equipment requiring duct detection.
5. Locate as specifically indicated in NFPA 72 and on installation instructions. Coordinate with supplier's representative prior to installation, exact location to ensure accurate sampling of air stream. Provide quantity as required by duct geometry.
6. Do not install head on sampling tube base in housing until final supplier testing, unless a protective cover is included with the detector head.

D. Remote Annunciator

1. Flush mounting.
2. Gangable switch box as required.
3. Minimum two #14 AWG conductors and one #18 AWG twisted shielded pair, or as required by manufacturer.

E. Fire Sprinkler System Equipment

1. See Mechanical Drawings and Specifications for locations and quantities.
2. Valve supervisory switches:
 - a. Integral contact shall serve as supervisory initiating device for separate "Address".
 - b. Supervisory only. Will not sound general alarm, or "Trouble".
3. Flow Switch:
 - a. Consists of two Form "C" (NO-NC) contacts.
 - b. One contact shall serve as alarm initiating device for separate "address".
 - c. Second contact shall control fire sprinkler alarm notification appliance. Connect to nearest 120 volt egress circuit. Provide transformer and relay as required.

3.3 TESTS

- A. Prior to final inspection, verify that the fire alarm system is in proper working condition, free from false alarms. Furnish a letter of verification to Engineer indicating that the system has been tested by manufacturer's representative and is found to be complete and functional. List date of test and name of manufacturer's representative. Indicate in letter that testing was in accordance with NFPA 72, Chapter 14, including re-acceptance testing when applicable. Include copies in control panel and Record Manuals.
- B. Notify Owner, Engineer, and Local Fire Marshall or Fire Chief one week in advance of scheduled tests. Electrical Contractor responsible for test coordination and scheduling.

3.4 INSTRUCTIONS

- A. Manufacturer's representative shall instruct Owner in proper operation, maintenance and testing of complete fire alarm and detection system. Indicate on letter of verification, name of Owner's representative receiving instructions.

- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

**SECTION 28 4913
RESCUE ASSISTANCE SYSTEM****PART 1 – GENERAL****1.1 DESCRIPTION****A. Work Included**

1. Furnish and install a complete IP based Rescue Assistance System operating on an isolated/proprietary supervised type network.

B. Description of Work

1. System to operate as follows:
 - a. Voice communication is initiated by depressing the Call Station button transmitting the signal to the Base Station. A programmable message and lighted button signals the caller that the alarm has been sent. The caller need not take any other action to communicate with the Base Station. An indicator light and screen message will signal the Base Station that a call has been received. Upon answering the call, a hands free, full-duplex communication channel is activated between the Base Station and Call Station.
 - b. If the call is not acknowledged at the base station after a programmed amount of time, the call is forwarded to a pre-programmed Remote Call Center. When the call is answered at the Remote Call Center, a hands free, full-duplex communication channel is activated between the Remote Call Center and the Call Station. The call can be interrupted/intercepted by the Base Station at any time.
 - c. In the event of a wiring fault, an indicator light and screen message appear on the Base Station.
 - d. The entire system shall comply with the Americans with Disabilities Act Accessibility Guidelines.

1.2 SUBMITTALS**A. Shop Drawings**

1. Submit information in accordance with Section 260500.
2. Indicate:
 - a. Mounting details.
 - b. Cabinet dimensions.
 - c. Wiring diagrams.
 - d. Description of devices.
 - e. Floor plan layout of devices.
 - f. Connection/riser diagram for specific project involved.

B. Record Manuals

1. Submit information in accordance with Section 260500.
2. Include information for operating and maintaining the system, including wiring diagrams, repair parts list, and all instructions accompanying equipment.

PART 2 – PRODUCTS**2.1 MANUFACTURER**

- A. The system specified is based on equipment as manufactured by Cornell Communications Solutions and other manufacturers as listed. All reference to model numbers and other pertinent information is intended to establish the standards of operational concepts, performance, quality and appearance which must be met.

2.2 EQUIPMENT**A. Control Panel (RACP)**

- 1. Full-duplex communication.
- 2. Supervised peripheral devices.
- 3. Support for 8 devices.
- 4. Integral modem that connects with VoIP and SIP telephone systems.
- 5. Integral 120 Volt power supply.
- 6. Standard IEA/TIA rack mount assembly (3RU).
- 7. Manufacturer: Cornell #SCM-4825.
 - a. Include rack mounted 1500VA UPS for backup power to control panel.

B. Expansion Module (RAEX)

- 1. Quantity as required to accommodate additional devices and/or to extend cabling distance limitations (320 feet) from devices to the control panel.
- 2. Support for 8 devices.
- 3. Wall mount enclosure.
- 4. Manufacturer: Cornell #ES-4808S
 - a. Include wall mounted 24VDC power supply with 3 hour battery backup.
 - b. Manufacturer: Cornell #B-5243A.

C. Base Station (RABS)

- 1. POE “telephone” style device with handset for communication.
- 2. Graphics display screen with customizable message displays.
- 3. Manufacturer: Cornell #A-4800BS.
 - a. Include wall mount enclosure with window and semi-flush trim ring.
 - b. Manufacturer: Cornell #BB-48S/BB-48TS.

D. Call Station (RACS)

- 1. POE emergency call device.
- 2. Provides hands free two-way voice communication.
- 3. Mushroom head push button call switch with indicating light.
- 4. Three-gang stainless steel faceplate with permanently silk-screened operator instructions.
- 5. Manufacturer: Cornell Communications Solutions #4800VS-3.
 - a. Include photoluminescent 8”x8” engraved Call Station Instructional Sign.
 - b. Manufacturer: Cornell #SN-C48.

PART 3 – EXECUTION**3.1 STORAGE**

- A. Store Rescue Assistance System components in a cool, dry space prior to installation.

3.2 INSTALLATION

A. General

1. Install in accordance with Code, product listing, and manufacturer's recommendations.
2. All wiring to comply with all National, State, and Local Fire Codes.
3. Exercise particular care in the installation of control rough in boxes to ensure plumb and level placement.
4. Cables:
 - a. Four-pair CAT 6 UTP Cable.
 - b. All cable runs shall be continuous. **NO SPLICING**
 - c. All cables shall be enclosed in conduit once leaving the network room.
5. Conduit:
 - a. Size per NEC, 1/2" minimum.
6. Terminations:
 - a. Connect all devices according to manufacturer's instructions.
 - b. Terminate all cables to RJ45 male connectors, T568B wiring scheme.
 - c. Identify all cables with location designations.
7. Locate devices as generally shown on Drawings and as specifically indicated on installation instructions. Verify exact locations with the Architect prior to rough-in.
8. Carefully plan cable routes to accommodate length limitations.
 - a. Provide RAEX modules as required to extend any cable runs that exceed length limits. Verify RAEX locations with Engineer.
 - b. Electrical contractor shall be responsible for additional equipment and cabling costs resulting from exceeded length limits due to conduit routing.
9. Install RACP in network rack as indicated. Verify exact rack position with Owner's IT representative.
 - a. Connect peripheral device cables directly to RACP. DO NOT terminate cables in a patch panel and utilize patch cords.
10. Provide CAT6 patch cable from RACP to Owner's telephone system network. Terminate cable in accordance with Owner's network cabling requirements.
11. Install Call Station Signs adjacent the Call Stations with fasteners. Adhesive mounting not acceptable. Verify exact locations with Architect.
12. Program system with call station location descriptions as per Owner's convention.
13. Configure system for communication through Owner's telephone system and program system for Owner's selected Remote Call Station information.

3.3 TESTING

- A. Prior to final inspection, verify that the Rescue Assistance Program system is in proper working condition. Furnish letter of verification to Engineer indicating that the system has been tested. List date of test and names of those in attendance.
- B. Notify Owner, Engineer, and local Fire Marshall or Fire Chief one week in advance of scheduled tests. Division 26 Contractor responsible for test coordination and scheduling.

3.4 INSTRUCTIONS

- A. Manufacturer's representative to instruct Owner in proper operation, maintenance and testing of the complete Rescue Assistance System. Indicate on letter of verification, name of Owner's representative receiving instructions.
- B. Record instructions and include with Record Manuals in accordance with Section 260500.

3.5 CLEANING

- A. **Clean** and **vacuum interior** to remove all wire and insulation scraps, dust and dirt.
- B. Clean all exposed surfaces immediately prior to final inspection.

END OF SECTION

SECTION 31 1000**SITework DEMOLITION AND REMOVAL****PART 1 GENERAL****1.1 SUMMARY****A. Section Includes:**

1. The removal and satisfactory disposal of pavement materials including concrete pavement, asphalt pavement, concrete driveways, sidewalks, curb and gutter aggregate base, and geotextile fabric.
2. The removal and disposal of designated utility structures, pipes, and related appurtenances.
3. The salvaging of designated materials when so indicated.

B. Related Sections include, but are not limited to:

1. Section 011100 – Summary of Work.
2. Section 014500 – Quality Control.
3. Section 015200 – Construction Facilities.
4. Section 311100 – Site Clearing.
5. Section 320550 – Restoration of Disturbed Areas.

1.2 PROTECTION**A. Confine Work and stockpiling to within designated areas on the Owner's property as approved by Engineer. Leave undisturbed all pavement and utility appurtenances not indicated for removal or renovation.****B. Maintain proper positive drainage during construction operations and through completion.****PART 2 PRODUCTS****2.1 NOT USED.****PART 3 EXECUTION****3.1 PREPARATION**

- A. Inspect and record existing conditions on site and at adjacent areas prior to starting construction.
- B. Become familiar with required lines of removal and saw cutting.
- C. Identify underground utilities.
- D. Provide, erect, and maintain adequate barriers and warning lights.
- E. Protect and maintain survey monuments or any construction staking from disturbance during pavement removal.
- F. Keep streets, sidewalks, alleys, and driveways in usable condition; avoid property owner inconvenience insofar as practicable; do not trespass on private property.

- G. Verify traffic control in place prior to commencement of pavement removal.
- H. Commencement of this Section's Work means acceptance of existing conditions.

3.2 REMOVAL

- A. Saw cutting is required on all concrete and asphalt pavements. Pavement removal beyond the limits established in the notes on the Drawings shall be replaced at the Contractor's expense.
- B. Saw cut vertically full depth to obtain a clean break. Remove on straight lines approximately parallel or perpendicular to centerline or pavement.
- C. Remove curb and gutter where indicated on Drawings, or as necessary to accomplish Contractor's work. All additional curb and gutter removal must be approved by Engineer and Owner. Curb and gutter removal not specified and without proper approval shall be replaced at the Contractor's expense.
- D. Disturbances, breakage, or damage to areas not designated for removal shall be restored at Contractor's expense prior to final payment.
- E. Pavement removed beyond the limits established shall be replaced to the same specifications as the adjacent removal at Contractor's expense.
- F. Remove entire width of sidewalk if replacement width is less than sidewalk width.
- G. Remove abandoned utility structures, pipes, and related appurtenances where indicated on the drawings or encountered by new construction. Fill trenches with Class 3 material, as specified in Section 312326, and compact to a minimum of 95% of maximum dry density determined by ASTM D698 (Standard Proctor).
- H. Where abandoned pipes are to remain in place, plug all exposed ends with concrete.
- I. Where abandoned structures are to remain in place, plug all pipe penetrations with concrete and fill structure with Class 3 material, as specified in Section 312326.

3.3 TOLERANCES

- A. Saw cut full depth to achieve a clean break. If required line of removal falls within 2 feet of an existing joint, adjust line of removal to be the existing joint.

3.4 DISPOSAL

- A. Remove broken pavement, pipes, utility structures, and appurtenances, and dispose of materials off site in Contractor furnished disposal area in a manner that is acceptable to local authorities and regulatory agencies.

END OF SECTION

SECTION 31 1100**SITE CLEARING****PART 1 - GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Protecting existing vegetation, utilities, and structures not designated for removal.
2. Removing trees designated for removal.
3. Topsoil removal.

B. Related Sections include, but are not limited to:

1. Section 31 2324 – Soil Materials.
2. Section 31 2200 – Grading.
3. Section 31 2316 – Excavation.
4. Section 31 2323 – Backfilling.
5. Section 31 2330 – Trenching.
6. Section 31 2223 – Landscape Grading.

1.2 SUBMITTALS

- A. Prior to site clearing, obtain sufficiently detailed photographs or videotape of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.

1.3 MATERIAL OWNERSHIP

- A. All excess or unsuitable soil materials shall be hauled and disposed of off-site in a Contractor furnished disposal area. Materials such as trees, vegetation, debris, trash and all other material identified by the owner as unsuitable shall become Contractor's property and shall be removed from the site to a disposal area furnished by the Contractor that is acceptable to local authorities and regulatory agencies.

1.4 PROJECT CONDITIONS

- A. Confine Work effort to within the Construction Limits shown on the drawings. Leave undisturbed all appurtenances not indicated for removal or renovation.

1.5 REGULATORY REQUIREMENTS

- A. Conform to all applicable regulations for proper disposal of debris.
- B. Coordinate clearing Work with utility companies.

PART 2 - PRODUCTS**2.1 MATERIALS**

- A. Topsoil: Refer to Section 312324.

PART 3 - EXECUTION**3.1 PREPARATION**

- A. Inspect and record with photographs or videotape existing conditions on site and at adjacent areas prior to starting construction.
- B. Identify underground utilities.
- C. Provide, erect, and maintain adequate barriers, fences and signs.
- D. Protect and maintain survey monuments or any construction staking from disturbance during removal.
- E. Verify that existing plant life designated to remain or be relocated is tagged or identified.
- F. Identify a disposal area for placing removed plant and soil materials.
- G. Beginning Work of this Section means acceptance of existing conditions.

3.2 PROTECTION

- A. Locate, identify, and protect those utilities, which are not designated for removal, from damage.
- B. Protect trees, plant growth, and features not designated for removal.
- C. Protect benchmarks, stakes, monuments, and existing structures from damage.

3.3 CLEARING

- A. Clear areas required for access to site and execution of Work. Remove plant growth and features only if designated to be removed.
- B. Contractor shall be responsible for all permanent tree removal. Remove only the trees and shrubs indicated in Drawings. Remove stumps, main root ball, and root system to a depth of 48 inches.
- C. Clear undergrowth and deadwood, without disturbing subsoil.

3.4 TOPSOIL REMOVAL

- A. Remove sod and grass and then excavate full depth of topsoil (minimum 12 inches) from areas to be further excavated, re-landscaped, or re-graded without mixing with foreign materials.
- B. Remove lumped soil, boulders, rock, debris, tree stumps and roots, and large weeds.
- C. Do not excavate wet topsoil.
- D. Sufficient quantity of excavated topsoil shall remain on project site for completion of final landscaping. Remove excavated topsoil to stockpile area designated by Owner and stockpile to a depth not exceeding 8 feet and protect from erosion.

3.5 DISPOSAL

- A. Disposal: Material not indicated to be stockpiled or to remain as Owner's property, such as trees, vegetation, obstructions, demolished materials, and waste materials, including trash and

debris, shall be removed and disposed of legally off Owner's property. All material designated to remain Owner's property shall be handled according to Owner's specifications.

- B. Excavated Topsoil: Shall be stockpiled in an area designated by the Construction Manager on the project site. Excavated topsoil will be available to Contractor for replacement in landscaped areas upon completion of construction. Dispose of excess or unsuitable topsoil in Contractor furnished off-site disposal area.

END OF SECTION

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SECTION 31 2200**SITE GRADING****PART 1 GENERAL****1.1 SUMMARY****A. Section includes:**

1. Removal of topsoil and subsoil.
2. Cutting, grading, filling, contouring, and compacting.
3. Furnishing borrow materials from off-site source if necessary to achieve plan grades.
4. This section includes excavating and filling for areas outside of building. Structural earthwork is covered in Section 31 2316.

B. Related Sections include, but are not limited to:

1. Section 31 1100 – Site Clearing.
2. Section 31 2316 – Earthwork.
3. Section 31 2324 – Soil Materials.
4. Section 31 2326 – Aggregate Materials.
5. Section 32 0550 – Restoration of Disturbed Areas.

1.2 REFERENCES**A. Reference Standards include, but are not limited to:**

1. ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
3. ASTM D2487 – Classification of Soils for Engineering Purposes.
4. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3017 – Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under provision of Section 01 7800.
- B. Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.

PART 2 PRODUCTS**2.1 MATERIALS**

- A. Subsoil Fill: Type S1 or S2 as specified in Section 31 2324.

PART 3 EXECUTION**3.1 EXAMINATION**

1. Verify that survey benchmark and intended elevations for the Work are as indicated.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Contractor shall be responsible for coordinating with all utility companies for location of buried utilities prior to excavation.
- C. Locate, identify, and protect all utilities that remain, from damage.
- D. Notify utility companies to remove and/or relocate utilities that interfere with construction.
- E. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- F. Protect benchmarks, survey control points, and existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.3 SUBSOIL EXCAVATION

- A. Excavate subsoil from areas to be further excavated, re-landscaped, or re-graded.
- B. Do not reuse excavated subsoil as backfill if wet unless material has been dried to obtain optimum moisture content.
- C. Stockpile subsoil to be reused in area designated on University of North Dakota property to depth not exceeding 8 feet and protect from erosion. Remove excess subsoil to off-site disposal area furnished by the Contractor.
- D. Stability: Replace damaged or displaced subsoil to same requirements as for specified fill.
- E. Compact sub-base to density requirements for subsequent backfill materials.
- F. Cut out soft areas of sub-base not capable of compaction in-place. Backfill with Type A1 fill as specified in Section 31 2326 and compact to density equal to or greater than requirements for subsequent fill material.
- G. Identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.
- H. Furnish imported borrow materials if sufficient suitable on-site materials are not available to achieve planned finished grades.

3.4 BACKFILLING

- A. Backfill areas to contours and elevations consistent with plan grades.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over loose, porous, wet, frozen, or spongy subgrade surfaces.
- C. Employ a placement method that does not disturb or damage other Work.
- D. Soil Fill: Place and compact material in equal continuous layers per the SCHEDULE section of this specification.
 - 1. Each layer shall be reasonably level and uniform and shall be thoroughly compacted with mechanical tampers to densities specified in the SCHEDULE section of this specification.

- E. Maintain optimum moisture content of backfill materials to attain required compaction density.
- F. Slope grade away from structures minimum 6 inches in 10 feet, unless noted otherwise.
- G. Make gradual grade changes. Blend slope into level areas.
- H. Remove surplus backfill materials from site. Contractor to bear all costs associated with loading and hauling excess fill off site to Contractor furnished disposal area.
- I. Leave fill material stockpile areas free of excess fill materials, restore to their original condition, and maintain these areas until the end of the warranty period.

3.5 TOLERANCES

- A. Top Surface of Backfilling Under Structures and Roadways: Plus or minus 0.1 feet from required elevations.
- B. Top Surface of General Backfilling: Plus or minus 0.2 feet from required elevations.

3.6 FIELD QUALITY CONTROL

- A. Perform compaction testing in accordance with ASTM D698 and ASTM D2922.
- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- C. Frequency of Density Tests: one (1) test per every 1000 square feet of subgrade material. For areas excavated beyond 2 feet of the surface, one (1) test shall be performed for every 2 feet of fill per 1000 square feet.

3.7 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 5000.
- B. Reshape and re-compact fills subjected to vehicular traffic.

3.8 SCHEDULE

- A. Fill to Correct Over-excavation:
 - 1. Fill Type A1 as specified in Section 31 2326, compacted to 95% standard proctor density (ASTM D698).
- B. Fill below paved and landscaped areas:
 - 1. Fill Type S1 or S2 as specified in Section 31 2324, compacted to 95% standard proctor (ASTM D698), and within +/- 5% of optimum moisture content.
 - 2. Lifts shall be no thicker than 9-inches. In the top 12-inches, lifts shall be no thicker than 6-inches.
- C. Subgrade Preparation below paved areas
 - 1. Scarify and recompact top 12 inches of earth subgrade as specified in 312310.
 - 2. Compact to a minimum of 98% of standard proctor density (ASTM D698) at 0 to 4% below optimum moisture content.

END OF SECTION

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SECTION 31 2223

LANDSCAPE GRADING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Subsoil preparation.
 - 2. Final grading of topsoil for finish landscaping.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 4500 – Quality Control.
 - 2. Section 31 2324 – Soil Materials.
 - 3. Section 32 0550 – Restoration of Disturbed Areas.
 - 4. Section 31 2330 – Trenching.
 - 5. Section 32 9219 – Seeding.

PART 2 PRODUCTS

2.1 MATERIAL

- A. Topsoil: Salvaged or Imported as specified in Section 312324.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify trench backfilling has been inspected prior to final grading.
- B. Verify substrate base has been contoured and compacted.

3.2 PREPARATION OF SUBSOIL

- A. Eliminate uneven areas and low spots.
- B. Maintain lines, levels, profiles, and contours. Make changes in grade gradual. Blend slopes into level areas.
- C. Remove debris, undesirable plants and their roots, weeds, branches, stones, and foreign materials in excess of ½-inch in size. Do not bur foreign material beneath areas to be sodded. Remove contaminated subsoil.
- D. Scarify surface to a depth of 5-inches where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.3 PLACING TOPSOIL

- A. Spread, level, and lightly compact topsoil in areas where sodding and restoration is required, to a minimum depth of 6-inches.
- B. Rake until smooth and level.

- C. Place topsoil during dry weather and on dry unfrozen subgrade.
- D. Fine grade topsoil to eliminate rough or low areas to ensure positive drainage. Maintain profiles and contour of subgrade.
- E. Remove roots, weeds, rocks, and foreign material from topsoil while spreading.
- F. Manually spread topsoil close to plant life and buildings to prevent damage.
- G. Lightly compact placed topsoil.
- H. Remove surplus subsoil and topsoil from site.
- I. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.4 TOLERANCES

- A. Top of Topsoil - Lawn/Landscape Areas: plus or minus 1/2-inch.
- B. Top of Topsoil - Sports Fields: plus or minus 1/4-inch in 10-feet.

3.5 PROTECTION

- A. Protect landscaping and other features remaining as final Work.
- B. Protect existing structures, fences, sidewalks, utilities, paving, and curbs.

END OF SECTION

SECTION 31 2250**TEMPORARY EROSION AND SEDIMENT CONTROL****PART 1 GENERAL****1.1 SECTION INCLUDES**

- A. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.
- B. Restoration of areas eroded due to insufficient preventative measures.
- C. Related Sections include, but are not limited to:
 - 1. Section 31 3419 – Geotextile Fabrics
 - 2. Section 31 2200 – Site Grading
 - 3. Section 31 2316 – Excavating
 - 4. Section 31 2330 – Trenching
 - 5. Section 32 0550– Restoration of Disturbed Areas
 - 6. Section 31 1100 – Site Clearing
 - 7. Section 31 2324 – Soil Materials
 - 8. Section 31 2223 – Landscape Grading
 - 9. Section 32 9000 – Planting
 - 10. Section 32 9200 – Turf Grasses
 - 11. Section 32 9219 – Native Grasses and Forbs Planting

1.2 REFERENCES

- A. General Permit Authorization to Discharge Storm Water Associated with Construction Activity under the National Pollutant Discharge Elimination System/State Disposal System Permit Program.
- B. ASTM D 4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus; 2005.
- C. ASTM D 4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 1999a (Reapproved 2004).
- D. ASTM D 4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2004.
- E. ASTM D 4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 1991 (Reapproved 2003).
- F. ASTM D 4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile; 2004.
- G. ASTM D 4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples, 2002.

1.3 PERFORMANCE REQUIREMENTS

- A. Comply with all requirements of the North Dakota Department of Health & Environmental Division of Water Quality for erosion and sediment control.
- B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained.
 - 1. Cosign on SWPP Permit obtained by Construction Manager.
- C. Timing: Put preventative measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- D. Erosion On- Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
 - 1. Control movement of sediment and soil from temporary stockpiles of soil.
 - 2. Prevent development of ruts due to equipment and vehicular traffic.
 - 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- E. Erosion Off-Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
 - 1. Prevent windblown soil from leaving the project site.
 - 2. Prevent tracking of mud onto public roads outside of the site.
 - 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 - 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- F. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - 2. If sediment basins are used as temporary preventative measures, pump dry and remove deposited sediment after each storm.
- G. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
- H. Open Water: Prevent standing water that could become stagnant.
- I. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

PART 2 PRODUCTS**2.1 MATERIALS****A. Vehicle Tracking Pad.**

1. The rock area shall be a minimum of 6 inches deep, extend the full width of the ingress/egress area and be at least 50 ft long; however, longer entrances may be required to adequately clean tires.
2. Geotextile fabric may be used to prevent migration of mud from the underlying soil into the rock.

B. Storm Sediment Filter.

1. Shall be one of the following.
 - a. Sandbags.
 - 1) Woven, polypropylene fabric sewn together with double stitching.
 - 2) Overall sandbag size shall be at least 12 x 24 inches.
 - 3) Bags shall be filled ½ full with sand.
 - b. Drop-in Sediment Trap.
 - 1) Geotextile Fabric unit that inserts into the inlet.
 - (a) Shall be:
 - (1) Dandy Sack by Dandy Products, Inc.
 - (2) Siltsack by ACF Environmental.
 - (3) or equal.

C. Silt Fences:

1. Store and handle fabric in accordance with ASTM D 4873.
2. Install with top of fabric at nominal height and embedment indicated on drawings.
3. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches, with extra post.
4. Fasten fabric to steel posts using "U" shaped clips.

D. Fiber Roll:

1. Each fiber roll shall be overlapped by 1 foot minimum and tied tightly together, to prevent flow between the fiber roll ends.
2. Fiber rolls shall be trenched and staked according to manufacturer's specifications.
3. Six inch fiber rolls shall be used for sheet flow protection on backslopes and foreslopes.
4. Twelve to twenty inch fiber rolls shall be used in ditch bottoms and in areas where shallow concentrated flow is present.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.2 PREPARATION

- A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.
- B. The Contractor shall follow all requirements of the current regulations.
- C. The Construction Manager shall develop a Storm Water Pollution Prevention Plan
- D. The Contractor and Construction Manager together shall complete any required stormwater documentation.

3.3 SCOPE OF PREVENTIVE MEASURES

- A. Vehicle Tracking Pad at Construction Entrances: Traffic-bearing aggregate surface.
 - 1. Width: As required; 20 feet, minimum.
 - 2. Length: 50 feet, minimum.
 - 3. Provide at each construction entrance from public right-of-way.
 - 4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- B. Natural vegetation shall be retained whenever feasible.
- C. Land grading and excavating shall be kept at a minimum to reduce the possibility of creating runoff and erosion problems which require extensive control measures.
- D. Land exposure shall be minimized in terms of area and time.
- E. Storm Sediment Filters.
 - 1. Place immediately after new storm sewer inlets are installed and immediately before land is disturbed adjacent to existing storm sewer inlets.

3.4 INSTALLATION

- A. Vehicle Tracking Pad.
 - 1. The rock area shall be a minimum of 6 inches deep, extend the full width of the ingress/egress area and be at least 50 ft long; however, longer entrances may be required to adequately clean tires.
 - 2. Geotextile fabric may be used to prevent migration of mud from the underlying soil into the rock.
- B. Storm Sediment Filters.
 - 1. Sandbags.
 - a. Place around inlet providing a minimum of 12 inch horizontal clearance.
 - b. Place a minimum of 3 bags in height with staggered joints.
 - 2. Drop-in Sediment Trap.

- a. Place as recommended by the manufacturer.

3.5 MAINTENANCE

- A. Inspect preventative measures weekly, within 24 hours after the end of any storm that produces 0.5 inches or more rainfall at the project site, and daily during prolonged rainfall.
 1. All inspections and maintenance conducted during construction shall be recorded in writing and retained in accordance with the storm water permit.
- B. All removed tree material shall become the property of the Contractor and shall be disposed of off-site in Contractor furnished disposal area.
- C. All stumps and roots shall be removed to a minimum of 3 feet below grade.
- D. Backfill excavation with suitable on-site soil materials or engineered fill compacted to a minimum of 95% of Standard Proctor Density, ASTM D698.
- E. Silt Fences:
 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 2. Remove silt deposits that exceed one-third of the height of the fence.
 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff of other causes.

3.6 CLEAN UP

- A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Engineer.
- B. Where removal of temporary measures would have exposed soil, shape surface to an acceptance grade and finish to match adjacent ground surfaces.

END OF SECTION

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SECTION 31 2310**SUBGRADE PREPARATION****PART 1 GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Scarifying, compacting, and shaping the earth subgrade.
2. Perform subgrade preparation on all areas to receive concrete pavement, bituminous pavement, sidewalk, shared use path, and aggregate base course.

B. Related Sections:

1. Section 01 4500 – Quality Control.
2. Section 31 1100 – Site Clearing.
3. Section 31 2200 – Site Grading.
4. Section 31 2323 – Backfilling.
5. Section 31 2330 – Trenching.
6. Section 32 1123 – Aggregate Base Course.
7. Section 32 1313 – Concrete Pavement.

1.2 REFERENCES**A. Reference Standards include:**

- B. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
- C. ASTM D2487 - Classification of Soils for Engineering Purposes.
- D. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- E. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- F. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

PART 2 PRODUCTS**2.1 OTHER MATERIALS**

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to approval of the Engineer.
- B. Suitable Soil Materials: On-site excavated material or imported borrow material meeting subsoil classification S1 or S2, as defined in Section 312324, free of rock or gravel larger than 2 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

PART 3 EXECUTION**3.1 GENERAL**

- A. Subgrade Preparation shall consist of producing a firm and stable subgrade prior to placement of the surface or base course.

3.2 SUBGRADE PREPARATION

- A. The Contractor shall compact and shape the subgrade for its full width as may be necessary to produce, at the time the base course is placed, the required density in the upper 12-inches of the base and the required grade and cross-section.
- B. The subgrade shall be prepared by scarifying the upper 12-inches of subgrade soil and compacting according to Section 312200. Subgrade preparation shall extend deeper than 12-inches if the Engineer believes that additional subgrade preparation is necessary to support construction.
- C. If areas are encountered that cannot be compacted, excavate unstable materials and replace with materials that can be compacted.
- D. Contractor shall be responsible for drying the subgrade soil or applying water as may be necessary to obtain the required density. Contractor shall also be responsible for grading the Work area and providing drainage so that accumulating water will drain away from the subgrade.
- E. The finished subgrade surface shall be smooth and uniform and shall not rut, shove, flex, or displace when subjected to any construction equipment loads.
- F. The required grade and cross-section for subgrades shall consist of a smooth subgrade surface that conforms to the prescribed elevations for the particular subgrade being prepared, prior to constructing an additional course thereon. The required grade and cross-section for rough graded surfaces shall consist of a smooth graded surface that conforms to the prescribed elevations for that particular rough grade being prepared. The prescribed elevation for any point on the subgrade or rough graded surfaces shall be as determined from the grades staked by the Engineer and the cross-sections as shown in the Plans. Contractor is responsible for verifying the accuracy of grades staked by the Engineer.
- G. Finish subgrade or rough graded surfaces shall not deviate by more than 0.05 feet from the required section and grade.
- H. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations, vehicular traffic, or weather conditions.

- I. Surface or base course shall not be placed on subgrades until the subgrade has been tested and Contractor has proven that the requirements specified herein have been met. Upon completion of a successful test, Contractor shall maintain the subgrade and repair any damage prior to placing subsequent materials.
- J. Subgrade preparation shall apply to all paved and graveled areas, including roads, streets, aprons, driveways, parking lots, sidewalks, and curb and gutter.

END OF SECTION

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SECTION 31 2316

EXCAVATING

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Excavating for utilities.
 - 2. Excavating for site structures.
 - 3. Site excavation.
- B. Related Section include:
 - 1. Section 31 2200 – Site Grading.
 - 2. Section 31 2323 - Backfilling.
 - 3. Section 31 2330 - Trenching.

1.2 FIELD MEASUREMENTS

- A. Verify that survey benchmark and intended elevations for the Work are as indicated.

PART 2 PRODUCTS

2.1 NOT USED.

PART 3 EXECUTION

3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities that remain from damage.
- C. Notify utility company to locate utilities.
- D. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- E. Protect bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.2 EXCAVATING

- A. Underpin adjacent structures that may be damaged by excavating work.
- B. Excavate subsoil to accommodate site structures, construction operations, and other work.
- C. Slope banks with machine to angle of repose or less, until shored.
- D. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- E. Dewater excavations encountering groundwater at no cost to Owner.
- F. Hand trim excavation. Remove loose matter.
- G. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume.

- H. Notify Engineer of unexpected subsurface conditions and discontinue affected Work in area until notified to resume work.
- I. Correct areas over excavated in accordance with Section 312323.
- J. Stockpile excavated material in approved area and remove excess or unsuitable material from site. Contractor shall bear all cost to remove, haul, and spread excess or unsuitable excavated material at Contractor furnished off-site disposal area.

3.3 FIELD QUALITY CONTROL

- A. Section 01 4000 - Quality Control: Field inspection and testing.
- B. Provide for visual inspection of bearing surfaces.

3.4 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.
- B. Maintain stability of adjacent structures. Use underpinning and shoring as necessary.
- C. Protect bottom of excavations and soil adjacent to and beneath structure from freezing.
- D. Comply with all Occupational Safety and Health Administration (OSHA) requirements.

END OF SECTION

SECTION 31 2323

BACKFILLING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Site structure backfilling to subgrade elevations.
2. Site filling and backfilling.
3. Fill under roadways.
4. Fill for over-excavation.
5. Consolidation and compaction as scheduled.

B. Related Sections include:

1. Section 01 4500 - Quality Control.
2. Section 01 5200 – Construction Facilities.
3. Section 31 2324 - Soil Materials.
4. Section 31 2326 - Aggregate Materials.
5. Section 31 2316 - Excavating.
6. Section 31 2330 - Trenching.
7. Section 321123 - Aggregate Base Course.
8. Section 31 2223 - Landscape Grading.

1.2 REFERENCES

A. Reference Standards include:

1. ASTM D698- Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
2. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
3. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS FOR REVIEW

- A. See Division 01 for submittal procedures.
- B. Samples: Submit, in air-tight containers, 40 pound sample of each type of fill to testing laboratory.

1.4 QUALITY ASSURANCE

- A. Section 01 4500 - Quality Control: Field Samples.
- B. Material Source: Submit name of imported material supplier(s). Provide materials from the same source throughout the Work. Change of source requires Engineer approval.

PART 2 PRODUCTS**2.1 FILL MATERIALS**

- A. Subsoil and Topsoil Fills: As specified in Section 31 2324.
- B. Aggregate Fills: As specified in Section 31 2326.
- C. Aggregate Base Course: as specified in Section 32 1123.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify sub-drainage, dampproofing, and waterproofing has been inspected.

3.2 PREPARATION

- A. Compact subgrade to density requirements for subsequent backfill materials.
- B. Cut out soft areas of subgrade not capable of compaction in-place. Backfill with Type A1 fill and compact to density equal to or greater than requirements for subsequent fill material.
- C. Identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.
- D. Dewater excavations during backfilling at no cost to Owner.

3.3 BACKFILLING

- A. Backfill areas to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over loose, porous, wet, frozen, or spongy subgrade surfaces.
- C. Aggregate Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- D. Soil Fill: Place and compact material in equal continuous layers not exceeding 8 inches compacted depth.
- E. Employ a placement method that does not disturb or damage other work.
- F. Maintain optimum moisture content of backfill materials to attain required compaction density.
- G. Slope grade away from structures minimum 6 inches in 10 feet, unless noted otherwise.
- H. Make gradual grade changes. Blend slope into level areas.
- I. Remove surplus backfill materials from site. Contractor to bear all costs associated with loading and hauling excess fill off-site to Contractor furnished disposal area.
- J. Leave fill material stockpile areas free of excess fill materials.

3.4 TOLERANCES

- A. Top Surface of Backfilling under Structures and Roadways: Plus or minus 0.1 feet from required elevations.

- B. Top Surface of General Backfilling: Plus or minus 0.2 feet from required elevations.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 4500 - Quality Control.
- B. Perform compaction testing in accordance with ASTM D698 and ASTM D2922.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- D. Frequency of Tests: One per every 2 feet of backfill height per 1000 square feet.

3.6 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 5200.
- B. Reshape and re-compact fills subjected to vehicular traffic.

3.7 SCHEDULE

- A. Fill Under Roadways and other paved areas:
 - 1. Compact subsoil to 95 percent of ASTM D698 maximum dry density.
 - 2. Fill Type S1 or S2, to 12 inches below finish elevation, compacted to 95 percent.
 - 3. Perform Subgrade Preparation and installation of aggregate base and pavement.
- B. Fill Under Berms and Grassed Areas:
 - 1. Fill Type S1 or S2, to 6 inches below grade, compacted to 95 percent of ASTM D698 maximum density.
 - 2. Cover with 6 inches of topsoil.
 - 3. Grade topsoil and prepare topsoil for seeding.
- C. Backfill of utility trenches:
 - 1. Fill Class 3 aggregate, in 6-inch compacted lifts, compacted to 95 percent of ASTM D698 maximum density, to 2 feet below finished subgrade elevation.
 - 2. Fill Type S2 (clay), in 8-inch compacted lifts, compacted to 95 percent of ASTM D698 maximum density, in two feet immediately below subgrade elevation.

END OF SECTION

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SECTION 31 2324**SOIL MATERIALS****PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Subsoil materials.
 - 2. Topsoil materials.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 4500 – Quality Control.
 - 2. Section 31 1100 – Site Clearing.
 - 3. Section 31 2200 – Grading.
 - 4. Section 32 0550 – Restoration of Disturbed Areas.
 - 5. Section 31 2330 – Trenching.
 - 6. Section 31 2223 – Landscape Grading.
 - 7. Section 32 9219 – Seeding.
 - 8. Section 32 9223 – Sodding.
 - 9. Section 32 9300 – Plants.

1.2 REFERENCES

- A. Reference Standards include, but are not limited to:
 - 1. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
 - 2. ASTM D2487 - Classification of Soils for Engineering Purposes.
 - 3. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 4. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 5. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.3 SUBMITTALS

- A. See Division 01 for submittal procedures.
- B. Samples: Submit in air-tight containers, 40 pound (lb.) sample of each type of fill to testing laboratory.

1.4 QUALITY ASSURANCE

- A. Section 014500 – Quality Control: Field Samples.
- B. Materials Source: Submit name of imported materials source.
- C. Provide materials from the same source throughout the Work. Change of source requires Engineer approval.

PART 2 PRODUCTS**2.1 SUBSOIL MATERIALS**

- A. Subsoil: Excavated material; Imported borrow and select or local borrow. Graded free of lumps larger than 3 inches, rocks larger than 2 inches, and debris.
 - 1. Type S1: Imported or Re-used; Fine sand and gravel, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Conforming to ASTM D2487 Group Symbol GM, GC, SM, and SC.
 - 2. Type S2: Imported or Re-used; Silt, silty-clay, inorganic clays, and silts of medium to high plasticity and liquid limits. Conforming to ASTM D2487 Group Symbol CL, ML, CH, and MH.
 - 3. Type S3: Non-used; All frozen material, vegetation, trash, rocks, and concrete and bituminous chunks having a dimension exceeding 3 inches.

2.2 TOPSOIL MATERIALS

- A. Topsoil: Salvaged and/or imported material meeting the requirements of Sections 329219, 329223 and 329300.

2.3 SOURCE QUALITY CONTROL

- A. Section 014500 – Quality Control: Testing and analysis of soil material.
- B. Contractor shall submit samples, obtain laboratory results, and submit for Engineer's approval.
- C. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698, ASTM D2487, and ASTM D4318.
- D. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D2487.
- E. If tests indicate materials do not meet specified requirements, change material and retest, at no cost to Owner.
- F. Provide materials of each type from the same source throughout the Work.

PART 3 EXECUTION**3.1 SOIL REMOVAL**

- A. Excavate subsoil and topsoil required from all areas designated for construction.
- B. Remove lumped soil, boulders, rock, and large weeds.
- C. Stockpile excavated material to be reused at location designated by Construction Manager on project site. Remove excess or unsuitable material not being reused to off-site disposal area furnished by Contractor.

3.2 STOCKPILING

- A. Stockpile materials at location acceptable to Owner. Remove and dispose of excess or unsuitable material in off-site disposal area furnished by Contractor.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.

- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination of stockpiled soils.
- E. Do not stockpile wet material. Excavated wet material must be processed to obtain optimum moisture content prior to stockpiling.
- F. Limit height of stockpile to 8 feet or as approved by the Engineer. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- G. Protect stockpiled materials from inclement weather. If materials are left without protection and become unusable due to moisture content, all costs associated with material replacement or farming will be the responsibility of the Contractor.

3.3 STOCKPILE CLEANUP

- A. Remove stockpile; leave area in a clean and neat condition. Grade site surface to prevent freestanding surface water.
- B. If a borrow area is used, leave area in a clean and neat condition. Grade site surface to prevent freestanding surface water.

END OF SECTION

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SECTION 31 2326**AGGREGATE MATERIALS****PART 1 GENERAL****1.1 SUMMARY****A. Section includes:**

1. Aggregate materials.
2. Source quality control.
3. Aggregate stockpiling and stockpile cleanup.

B. Related Sections include, but are not limited to:

1. Section 01 4500 – Quality Control.
2. Section 31 2324 – Soil Materials
3. Section 32 0550 – Restoration of Disturbed Areas.
4. Section 31 2316 – Excavating.
5. Section 31 2323 – Backfilling.
6. Section 31 2330 – Trenching.
7. Section 32 1123 – Aggregate Base Course.
8. Section 32 1313 – Concrete Pavement.
9. Section 33 1116 – Site Water Lines.
10. Section 33 3111 – Sanitary Sewage System.
11. Section 31 2223 – Landscape Grading.

1.2 REFERENCES**A. Reference Standards include:**

1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
3. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
4. ASTM D2487 - Classification of Soils for Engineering Purposes.
5. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
7. ASTM D4318 - Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
8. North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.

1.3 SUBMITTALS FOR REVIEW**A. See Division 01 for submittal procedures.****B. Samples: Submit in air-tight containers, 40 pound (lb.) sample of each type of fill to testing laboratory.**

1.4 QUALITY ASSURANCE

- A. Section 014500 Quality Control: Field Samples.
- B. Materials Source: Submit name of imported materials source.
- C. Provide materials from the same source throughout the Work. Change of source requires Engineer approval.

PART 2 PRODUCTS**2.1 AGGREGATE MATERIALS**

- A. Fine Aggregate (Type A4): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM C33.
- B. Coarse Aggregate (Type A1): Well graded crushed stone or gravel conforming to the requirements of ASTM C33, Gradation 67.
- C. PVC Water Pipe Bedding Aggregate: Class 6 aggregate graded in accordance with ASTM C136, within the limits specified in the table within this section.
- D. Coarse Aggregate (Base Course and Type A3): Gravel; Angular crushed, or natural stone; free of shale, clay, friable material and debris; of one of the following three materials:
- E. Class 5 Aggregate as specified in North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
 - 1. Crushed Recycled Concrete Pavement. Maximum size of crushed material shall be 1 ½ inches. Maximum percentage passing the #200 sieve shall be 10 percent. Material shall be blended to provide a uniform consistent mixture. Rubble material from building demolition shall not be acceptable.
- F. See the following table for grain size distributions applicable to Aggregates.

<u>DESIGNATION</u>	<u>CLASS 3</u>	<u>CLASS 5</u>	<u>CLASS 2</u>	<u>CLASS 4 *A</u>	<u>SIZE 2</u>	<u>CLASS 6 *A</u>	<u>CLASS 27</u>	<u>SPECIAL CLASS 1 PVC1</u>
<u>SIEVE SIZE</u>	<u>TOTAL PERCENT PASSING</u>							
<u>2"</u>					<u>100</u>			
<u>1-1/2"</u>	<u>100</u>				<u>90-100</u>			
<u>1"</u>		<u>100</u>			<u>20-55</u>			

<u>3/4"</u>		<u>90-100</u>	<u>100</u>	<u>100</u>	<u>0-15</u>	<u>100</u>		<u>100</u>
<u>5/8"</u>							<u>100</u>	<u>92-100</u>
<u>1/2"</u>							<u>70-100</u>	
<u>3/8"</u>			<u>50-95</u>		<u>0-5</u>	<u>90-100</u>		<u>36-64</u>
<u>NO. 4</u>	<u>35-85</u>	<u>35-70</u>		<u>35-85</u>		<u>35-75</u>	<u>40-70</u>	<u>19-28</u>
<u>NO. 8</u>							<u>33-55</u>	
<u>NO. 10</u>			<u>0-15</u>					
<u>NO. 16</u>							<u>25-45</u>	<u>9-16</u>
<u>NO. 30</u>	<u>20-50</u>	<u>16-40</u>	<u>0-4</u>	<u>10-50</u>			<u>15-35</u>	
<u>NO. 50</u>							<u>10-30</u>	
<u>NO. 100</u>								<u>0-2</u>
<u>NO. 200</u>	<u>0-15</u>	<u>4-10</u>		<u>0-20</u>		<u>0-8</u>	<u>2.0-9.0</u>	
<u>SHALE *B</u>	<u>12%</u>	<u>12%</u>		<u>15%</u>			<u>5%</u>	
<u>LA ABRASION</u> <u>*B</u>	<u>50%</u>	<u>50%</u>		<u>50%</u>			<u>40%</u>	
<u>PLASTICITY</u>				<u>10-30</u>			<u>3</u>	

<u>INDEX *C</u>								
<u>FRACTURED FACES *D</u>		<u>10%</u>		<u>10%</u>			<u>50%</u>	

2.1 NOTES:

- A. Special Designation – not comparable NDDOT specification
- B. Maximum Percentage
- C. Determined on Minus No. 200 Material.
- D. Minimum percentage with at least 2 fractured faces, determined on Plus No. 8 Material.

2.2 SOURCE QUALITY CONTROL

- A. Section 014500- Quality Control: Source testing and analysis of aggregate material.
- B. Contractor shall submit samples, obtain laboratory results, and submit for Engineer's approval.
- C. Coarse Aggregate Material – Testing and Analysis: Perform in accordance with ASTM C136, ASTM D698 and ASTM D3017. Provide one test for each stockpile used, new test for every change in material.
- D. Fine Aggregate Material – Testing and Analysis: Perform in accordance with ASTM C136, ASTM D698 and ASTM D3017. Provide one test for each stockpile used, new test for every change in material.
- E. Aggregates Intended for Bedding or Backfill – Testing and Analysis: Perform moisture density relationship and moisture content testing in accordance with ASTM C136, ASTM D698 and ASTM D3017. Perform one test for each change in bedding or backfill material source.
- F. If tests indicate materials do not meet specified requirements, change material or material source and retest.
- G. Provide materials of each type from the same source throughout the Work.

PART 3 EXECUTION**3.1 STOCKPILING**

- A. Stockpile materials on site in an area within construction limits. Remove and dispose of legally from the site unsuitable, excess material not being used.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of material types or contamination of stockpiled materials.
- E. Limit height of stockpile to 72 inches. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.2 STOCKPILE CLEANUP

- A. Remove stockpile, leave stockpile area in a clean and neat condition. Grade site surface to prevent free standing surface water.
- B. Leave borrow areas in a clean and neat condition. Grade site surface to prevent free standing surface water.

END OF SECTION

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SECTION 31 2330**TRENCHING****PART 1 GENERAL****1.1 SUMMARY****A. Section includes:**

1. Excavating trenches for utilities.
2. Compacted bedding and fill of utilities to subgrade elevations.
3. Backfilling and compaction.

B. Related Sections include:

1. Section 01 4500 – Quality Control.
2. Section 01 5200 – Construction Facilities.
3. Section 31 1100 – Site Clearing.
4. Section 31 2324 – Soil Materials.
5. Section 31 2326 – Aggregate Materials.
6. Section 31 2200 – Grading.
7. Section 32 0550 – Restoration of Disturbed Areas.
8. Section 31 2316 – Excavating.
9. Section 31 2323 – Backfilling.
10. Section 32 1123 – Aggregate Base Course.
11. Section 33 1116 – Site Water Lines.
12. Section 33 3111 – Sanitary Sewage System.
13. Section 31 2223 – Landscape Grading

1.2 REFERENCES**A. Reference Standards include:**

1. ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
2. ASTM D698- Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
3. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate in place by Nuclear Methods (Shallow Depth).

1.3 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable, excluding manholes.

1.4 FIELD MEASUREMENTS

- A. Verify that survey benchmark, survey control point, and intended elevations for the Work are as shown on Drawings.

1.5 COORDINATION

- A. If conflicts with existing utilities are discovered, immediately contact the Engineer.

1.6 PROTECTION

- A. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in or loose soil from falling into excavation.
- B. Underpin adjacent structures that may be damaged by excavation, including buildings, service utilities, pipes, and trees, which are to remain.
- C. Notify Engineer of unexpected subsurface conditions and discontinue work in affected area until instructed to resume work. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- D. Limit the length of open trench as noted on the Drawings and provide temporary safety fence around open excavations to prevent unauthorized access.
- E. Grade excavation top perimeter to prevent surface water run-on into excavation.

PART 2 PRODUCTS**2.1 FILL MATERIALS**

- A. Subsoil Fill: As specified in Section 31 2324.
- B. Aggregate Fill: As specified in Section 31 2326.
- C. Aggregate Base Course: As specified in Section 32 1123.

2.2 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to the approval of the Engineer.

PART 3 EXECUTION**3.1 PREPARATION**

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, maintain, and protect utilities that remain from damage.
- C. Notify utility company to locate utilities.
- D. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- E. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- F. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type A1 and compact to density equal to or greater than requirements for subsequent backfill material.

3.2 EXCAVATING

- A. Excavate topsoil in accordance with Section 31 1100.
- B. Excavate subsoil required for installation of utilities to required depths.
 - 1. Limit length of open trench to 200 lineal feet at any one time.

2. Prevent inflow of surface water into trench.
 3. Dewater excavation, as required, to prevent accumulation of groundwater during pipe installation and backfilling at no cost to Owner.
- C. Excavate subsoil required for installation of utilities to required depth and alignment and only so far in advance of pipe laying as shown on Drawings or approved by Engineer. Trenches shall be excavated to depths at least four (4) inches below the required pipe grade and be backfilled with four (4) inches of select granular backfill conforming to requirements set forth in Section 31 2323.
- D. Trench width may vary with and depend upon the depth of the trench, the number of pipelines being installed in close proximity to each other, existing utilities in close proximity to the trench, and the nature of the excavated material encountered. Cut trenches sufficiently wide to enable pipe or utility installation, allow inspection, and allow proper backfilling. Trench width shall be determined by the Contractor and based on the Contractor's best practices and selected method for trenching the area to adequately accommodate the installation of each of the pipelines proposed in the project. Excavation and the associated surface restoration beyond the construction limits of the project will be the sole responsibility of the Contractor.
- E. Follow OSHA standards for trench excavations and ensure that trenches are braced and drained so that workmen may work therein safely and efficiently.
- F. Hand trim excavation as required for piping and fitting installation.
- G. Remove concrete or other debris, lumped subsoil, boulders, and rock up to 1/3 cubic yard, measured by volume. Provide a clearance of at least four (4) inches on all sides of the pipe and adequate clearance for properly joining pipe sections at bell holes. Excavation below grade in rock or boulders shall be backfilled with thoroughly compacted pipe bedding material for which the Contractor will receive no extra compensation.
- H. Excavation, stockpiling, and backfilling activities for pipes shall be conducted in a manner causing the least interruption to traffic and the Work of others on the Site.
- I. Stockpile excavated material in an orderly manner, at sufficient distance from the trench to avoid overloading, to prevent slides and cave-ins. Do not obstruct sidewalks, driveways, streets or drainage ways. Excess or unsuitable material excavated from trench shall become Contractor's property and shall be removed from the site in a legal manner.
- J. Provide drainage surrounding trench continually preventing inflow of surface water into trench. Water shall not be permitted to accumulate in the trench. Dewater excavation, as required, to prevent accumulation of groundwater during pipe installation and backfilling at no cost to

Owner. Discharge shall be led to natural drainage channels or storm sewers. Comply with storm water runoff control permit.

- K. Prevent displacement or loose soil from falling into excavation.
- L. Notify Engineer of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- M. Where the bottom of the trench uncovered at subgrade is soft and unable to support the pipe, further depth shall be excavated and refilled to pipe foundation grade with thoroughly compacted Type A1 aggregate per Section 312326. This Work shall be considered incidental to construction.
- N. In the event of shrinkage of excavated soils, resulting in shrinkage of backfill along trenches, Contractor shall provide, haul, place, and compact suitable material at no additional cost to Owner.
- O. Provide uniform bearing support for each pipe section along its entire length.
- P. Hydrants under pressure, valve boxes, curb stop boxes, and other utility controls shall be left unobstructed and accessible during the construction period.
- Q. Trees, fences, poles, and all other property shall be protected or removed and replaced as authorized by the Owner and any property damaged shall be satisfactorily restored by the Contractor.

3.3 BACKFILLING

- A. As specified in Section 31 2323.

3.4 TOLERANCES

- A. Top surfaces specified in Sections 31 2200 and 31 2323.

3.5 FIELD QUALITY CONTROL

- A. See Section 014500 - Quality Control.
- B. Perform compaction testing in accordance with ASTM D698 and ASTM D2922.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.
- D. Frequency of Tests: In accordance with Section 31 2323 Backfilling.

3.6 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 5200.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.
- C. Clean pavements adjacent to trenches during construction as required or directed by Engineer.

3.7 SCHEDULE

- A. Sanitary Sewer and Water Main Piping:

1. Pipe bedding and initial backfill as specified in Section 31 2326, from bottom of excavation to elevation as shown on Drawings, compacted to 95 percent of ASTM D698 maximum dry density.
2. Cover pipe and bedding with Class S1 or S2 Soil Material, in 6-inch compacted lifts, compacted to 95 percent of ASTM D698 maximum dry density to finished subgrade elevation.

END OF SECTION

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SECTION 31 3419**GEOTEXTILE FABRIC****PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Woven Geotextile Fabric.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 4500 – Quality Control.
 - 2. Section 31 2200 – Grading.
 - 3. Section 32 1123 – Aggregate Base Course.

1.2 REFERENCES

- A. Reference Standards include, but are not limited to:
 - 1. North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
 - 2. ASTM D3786 – Mullen Burst.
 - 3. ASTM D4355 – UV-Resistance.
 - 4. ASTM D4491 – Permittivity.
 - 5. ASTM D4595 – Wide Width Tensile Strength.
 - 6. ASTM D4632 – Grab Tensile Strength and Elongation.
 - 7. ASTM D4751 – Apparent Opening Size (AOS).
 - 8. ASTM D4833 – Puncture and Trapezoid Tear.
 - 9. ASTM D4873 – Guide for Identification, Storage, and Handling of Geosynthetics

1.3 SUBMITTALS

- A. See Division 01 for submittal procedures.
- B. Provide product data on Geotextile Fabric.
- C. Submit manufacturer's installation instructions. Indicate special procedures and conditions requiring special attention.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. The geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement.
- B. Rolls shall be stored in a manner which protects them from the elements. At no time shall the geotextile be exposed to ultraviolet light for a period exceeding fourteen days.
- C. The geotextile rolls shall be labeled as per ASTM D 4873, "Guide for Identification, Storage, and Handling of Geosynthetics".

PART 2 PRODUCTS**2.1 MATERIAL**

- A. Type R1 Geotextile fabric as specified in Section 816 of the North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition for use beneath pavement and aggregate base. Mirafi 600x geotextile, or approved equal, is also approved as woven fabric.

2.2 QUALITY CONTROL

- A. Manufacturing Quality Control: Tests shall be performed at an accredited laboratory for tests required for the geotextile and geogrid, at frequency meeting or exceeding ASTM procedure.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify subgrade has been inspected, gradients and elevations are correct; surface is dry, and ready to receive Work.

3.2 PREPARATION OF SUBSOIL

- A. Correct irregularities in subgrade gradient and elevation by scarifying a minimum of 6-inches, reshaping, and re-compacting.
- B. Do not place on soft, muddy, or frozen surfaces.

3.3 PLACEMENT

- A. The geotextile shall be laid out smooth without wrinkles or folds on the prepared subgrade in the direction of the construction traffic.
- B. Adjacent geotextile rolls shall be overlapped a minimum of 2.5 feet, ends of rolls shall be overlapped 3 feet.
- C. On curves, the fabric may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and shall be held in place by staples, pins or aggregate piles.
- D. Damaged areas shall be repaired by overlaying the area with sufficient material to overlap on all edges by at least 2.5 feet.
- E. The aggregate base material shall be placed by end dumping onto the geotextile from the edge or over previously placed base aggregate. Construction equipment shall not be allowed directly on the geotextile fabric.
- F. A minimum of 12" of aggregate must be placed on the geotextile prior to the movement of construction equipment above the fabric.

- G. Turning movements must be carefully monitored to avoid rutting of the aggregate. Any ruts occurring during construction shall be filled with additional gravel aggregate and compacted to the specified density.
- H. If placement of the backfill causes damage to the geotextile, the damaged area shall be repaired as described in Section 3.03.D.
- I. Install geotextile fabric and 12" aggregate base material beneath areas of bituminous and concrete pavement, and other site surfacing as shown on typical sections.

3.4 FIELD QUALITY CONTROL

- A. Section 01 4500 - Quality Control: Field inspection.

END OF SECTION

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SECTION 32 0550

RESTORATION OF DISTURBED AREAS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Restoration of areas designated for restoration.
2. Restoration of all items not specifically identified for restoration, but damaged through construction.
3. Restoration of paved surfaces.
4. Restoration of parking lots.
5. Restoration of driveways, sidewalks, curb and gutter, and brick pavers.
6. Clean up.

B. Related Sections include, but are not limited to:

1. Section 01 7700 – Closeout Procedures.
2. Section 31 2200 – Grading.
3. Section 31 2324 – Soil Materials.
4. Section 31 2326 – Aggregate Materials.
5. Section 32 1123 – Aggregate Base Course.
6. Section 32 1216 – Bituminous Pavement.
7. Section 32 1313 – Concrete Pavement
8. Section 31 2223 – Landscape Grading.
9. Section 32 9200 – Turf Grasses.

1.2 REFERENCES

A. References include, but are not limited to:

1. NDDOT Standard Specifications for Road and Bridge Construction, latest edition.

PART 2 PRODUCTS

2.1 MATERIALS

A. Material Sections Include:

1. Soil Materials: Per Section 31 2324.
2. Aggregate Material: Per Section 31 2326.
3. Bituminous Pavement: Per Section 32 1216.
4. Concrete Pavement: Per Section 32 1313.
5. Seeding: Per Section 32 9219.

PART 3 EXECUTION

3.1 EXECUTION

- A. Observe all surface features requiring protection, removal and replacement, and/or restoration prior to construction.

- B. The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location and shall not move them until directed.
- C. The Contractor shall be responsible for all damage or injury to property of any character during the prosecution of the Work, resulting from any act, omission, or neglect in the manner or method of executing the Work, or at any time due to defective Work or materials. This responsibility will not be released until the project has been completed and accepted.
- D. When any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, or neglect, in the execution of the Work, or in consequence of the non-execution thereof by the Contractor, Contractor('s) shall restore, at Contractor('s) own expense, such property to the condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or Contractor('s) shall make good such damage or injury in an acceptable manner.

3.2 RESTORATION

- A. Restore all areas disturbed by construction to a condition equal to or better than existed prior to construction.
- B. Replace, restore, repair, or otherwise make good any damage done to any tree, bush, or shrub, which is not specifically designated for removal.
- C. Restore items such as street signs, power poles, fences, retaining walls, streetlights, and others, whether or not specifically identified on the Plans, to a condition equal to or better than existed before construction.
- D. Restore pavement markings on surfaces that were removed or damaged to match existing markings with suitable material to meet the North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
- E. Restoration Schedule:
 - 1. Bituminous Pavement: Restore in kind as necessary because of construction activity.
 - 2. Sidewalk/Bikepath: per Section 32 1313 and Drawings.
 - 3. Concrete Pavement: per Section 32 1313 and Drawings.
 - 4. Berms and Lawn Areas: place topsoil per Section 31 2223 and seed areas disturbed by construction per Section 32 9200.
- F. Remove all excess dirt, concrete, forms, lumber, and debris from project site immediately upon completion of Work.
- G. Contractor shall be required to clean paved areas to their original condition before final payment will be made per Section 01 7700.

- H. Prior to re-opening any portion of Work completed, all streets, sidewalks, driveways, handicap curb ramps, parking lots, and curb and gutter shall be installed.
- I. All damage done to streets, driveways, sidewalks, parking lots, berms, etc., due to the Contractor's construction techniques shall be repaired at the Contractor's expense prior to final payment.

END OF SECTION

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SECTION 32 1123

AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Aggregate base course.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 4500 – Quality Control.
 - 2. Section 31 2324 – Soil Materials
 - 3. Section 31 2326 – Aggregate Materials.
 - 4. Section 31 2200 – Grading.
 - 5. Section 32 0550 – Restoration of Disturbed Areas.
 - 6. Section 31 2323 – Backfilling.
 - 7. Section 31 2330 – Trenching.
 - 8. Section 32 1313 – Concrete Pavement.

1.2 REFERENCES

- A. Reference Standards include, but are not limited to:
 - 1. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
 - 2. ASTM D2167 – Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 3. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 4. ASTM D3017 – Test Methods for Moisture Content of Soil and Soil-Aggregate in place by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS FOR REVIEW

- A. See Division 01 for submittal procedures.
- B. Samples: Submit, in air-tight containers, 40 lb. Sample of each type of fill to testing laboratory.
- C. Materials Source: Submit name of imported materials supplier(s). Provide materials from same source throughout the Work. Change of source requires Engineers approval.
- D. Laboratory Results: Submit in accordance with Section 01 3300 Submittal Procedures.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Base Course
 - 1. Course aggregate fill Type A3: as specified in Section 31 2326.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify subsoil has been inspected; gradients and elevations are correct.
- B. Verify subsoil is compacted to specified density and that subgrade test results have been submitted prior to placing aggregate course.
- C. Verify subgrade is dry.

3.2 PREPARATION

- A. Correct irregularities in subsoil gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

- A. Place aggregate in maximum 6-inch layers and compact to specified density.
- B. Level and contour surfaces to elevations and gradients indicated.
- C. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
- D. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

- A. Flatness: Maximum variation of ¼ inch measured with 10-foot straight edge.
- B. Scheduled Compacted Thickness: Within ½ inch.
- C. Variation from Design Elevation: Within ½ inch.

3.5 FIELD QUALITY CONTROL

- A. Section 01 4500 - Quality Control: Field inspection and testing.
- B. Compaction testing shall be performed in accordance with ASTM D698 and ASTM D2922.
- C. Contractor shall perform one compaction tests for each 2000 square feet.
- D. If, during progress of Work, tests indicate that compacted materials do not meet specified requirements, remove defective Work, replace, and retest. Contractor to bear all costs associated with defective pavement Work.

3.6 SCHEDULES

- A. Base Course under Trench: As specified in Section 31 2323.
- B. Base Course under Sidewalk: Minimum thickness of 6 inches of Type A3 aggregate base per Section 31 2326. Level and compact base course to 98 percent of maximum ASTM D698 dry density.

- C. Base Course under Concrete Pavement: Minimum thickness of 12 inches of Type A3 aggregate base per Section 31 2326. Level and compact base course to 98 percent of maximum ASTM D698 dry density in 6-inch lifts. When geotextile is used, place entire 12 inch depth in one lift.

END OF SECTION

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SECTION 32 1216**BITUMINOUS PAVEMENT****PART 1 GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Bituminous Pavement for roads, streets, driveways, and parking lots.
2. Bituminous Pavement for patching, tapers, and transitions.

B. Related Work:

1. Section 01 4500 – Quality Control.
2. Section 31 1100 – Site Clearing.
3. Section 31 2326 – Aggregate Materials.
4. Section 32 0550 – Restoration of Disturbed Areas.
5. Section 32 1123 – Aggregate Base Course.

1.2 REFERENCES**A. Reference Standards include, but are not limited to:**

1. ASTM D946 – Penetration-Graded Asphalt Cement for Use in Pavement Construction, Latest Edition.
2. ASTM D1559 – Test of Resistance to Plastic Flow of Bituminous Mixtures. Using Marshall Apparatus, Latest Edition.
3. ASTM D2950 – Test for Density of Bituminous Concrete in Place by Nuclear Methods, Latest Edition.
4. TAI – (The Asphalt Institute) – MS-2 Mix Design Methods for Asphalt Concrete and Other Hot Mix Types, Latest Edition.
5. TAI – (The Asphalt Institute) – MS-3 Asphalt Plant Manual, Latest Edition.
6. TAI – (The Asphalt Institute) – MS-8 Asphalt Paving Manual, Latest Edition.
7. TAI – (The Asphalt Institute) – MS-19 Basic Asphalt Emulsion Manual, Latest Edition.
8. North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition

1.3 SUBMITTALS FOR REVIEW**A. See Division 01 for submittal procedures.**

- B. Product Data:** Furnish data on aggregates, asphalt cement, bituminous mixtures, and other materials required for the mix in accordance with Section 014500 at least seven (7) days prior to beginning pavement operations. Engineer must approve job mix formula prior to its use on Project.

1.4 PERFORMANCE REQUIREMENTS AND QUALITY ASSURANCE

- A. Perform Work** in accordance with the North Dakota Department of Transportation Standard Specifications for Construction, latest edition.
- B. Obtain all materials** from same source throughout project.

- C. Paved surfaces shall not develop failures or unusual cracking as determined by the Engineer within twelve months of placement.
- D. The Contractor shall utilize an independent testing firm for the development of the mix design and gradation of the aggregate mix. The cost associated with these test requirements shall be included in the Contractor's bid.

1.5 REGULATORY AND ENVIRONMENTAL REQUIREMENTS

- A. Do not place asphalt when ambient air temperature (in the shade and away from artificial heat) or base surface temperature is less than 40° F, or when surface is wet, dirty, or frozen.
- B. No Work will be permitted in the spring until the frost has disappeared and the subgrade is stable so as to support the equipment without rutting, shoving, pumping, or other displacement.
- C. Conform to the NDDOH Standards.
- D. Dispose of all waste material or reject material by approved methods.

PART 2 PRODUCTS

2.1 GENERAL

- A. Asphalt Cement:
 - 1. ASTM D946 (AASHTO M-20) Asphalt Cement having a 120/150 penetration grade in accordance with Section 2360 of the NDDOT Standard Specifications.
 - 2. PG58-28 Performance Graded Asphalt Cement meeting AASHTO M320 in accordance with NDDOT Standard Specifications.
- B. Aggregate for Mix:
 - 1. Class 29 per Section 816 of the North Dakota Department of Transportation Standard Specifications for Construction, latest edition.
- C. Bituminous Mixture (Base Course) shall have the following properties:
 - 1. The Engineer shall approve the job mix formula submitted by the Contractor. Once the job mix formula is established, all mixtures furnished for the Project shall conform within the following maximum permissible variation:
 - 2. Aggregate passing No. 4 and larger sieves.....+ or - 5.0%
 - a. Aggregate passing No. 8 to No. 100 sieves.....+ or - 3.0%
 - b. Aggregate passing No. 200 sieves.....+ or - 2.0%
 - c. Asphalt.....+ or - 0.15%
 - d. Temperature of mixture.....+ or - 20° F.
 - e. The asphalt mixture shall have the following test properties:
 - 1) Marshall Stability.....1200 lbs. (minimum)
 - 2) Marshall Flow (units of 0.01 in.).....8 to 18

- 3) Air Voids.....3 to 6 percent
- 4) Target Air Voids for Mix Design.....4 percent
3. Adjustment of the job-mix base course formula shall be made if and as directed by the Engineer without adjustment in the contract unit price.
- D. Bituminous Mixture (Wear Course) shall have the following properties:
 1. The Engineer shall approve the job mix formula submitted by the Contractor. Once the job mix formula is established, all mixtures furnished for the Project shall conform within the following maximum permissible variation:
 - a. Aggregate passing No. 4 and larger sieves.....+ or - 5.0%
 - b. Aggregate passing No. 8 to No. 100 sieves.....+ or - 3.0%
 - c. Aggregate passing No. 200 sieves.....+ or - 2.0%
 - d. Asphalt.....+ or - 0.15%
 - e. Temperature of mixture.....+ or - 20° F
 - f. The asphalt mixture shall have the following test properties:
 - 1) Marshall Stability.....1200 lbs. (minimum)
 - 2) Marshall Flow (units of 0.01 in.).....8 to 18
 - 3) Air Voids.....3 to 5 percent
 - 4) Asphalt Cement content shall be increased 0.2% above that of the base course mix.
 2. Adjustment of the job-mix wear course formula shall be made if and as directed by the Engineer without adjustment in the contract unit price.
- E. Tack Coat:
 1. Emulsion tack shall be in accordance with MNDOT Standard Specifications.
 2. Water shall be clean and free of impurities, either in solution or colloidal suspension.
 3. Emulsifying agents must be checked for compatibility with the water and the asphalt cement being used.
 4. All tack oil shall be diluted with water at a 50:50 ratio.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that compacted subgrade or base course is dry, stable, compacted to specified density, at proper temperature, and to proper elevations and grade slopes. Do not begin asphalt-pavement patching work without Engineer's authorization.

- B. Each course shall be compacted and hardened to such a degree that it will not be displaced or otherwise damaged before another course may be placed thereon.

3.2 PREPARATION

- A. Notify Engineer and Owner at least 72 hours in advance of temporary disruptions of traffic along route of construction.
- B. Fine grade and compact surface of aggregate base course.
- C. Saw cut and tack all joints between new and existing pavement.

3.3 TACK COAT

- A. Apply tack coat as directed in Section 401 of the NDDOT Standard Specifications for Road and Bridge Construction, latest edition.
- B. Apply bituminous tack coat to existing bituminous pavement including edges of abutting pavement, and to the surface of each lift or course constructed, other than the final course. Apply in a uniform rate with no missed areas permitted. Application rates shall be approved by the Engineer prior to commencing Work.
- C. Apply immediately prior to the placement of the next bituminous course or lift. Do not allow public traffic on tack coated areas.
- D. Apply the tack coat on the same day as the proposed surfacing is to be performed. Where emulsified asphalt is specified, dilute one part of water to one part of emulsion and apply the mixture at two times the undiluted rate of application. Allow water to evaporate completely before beginning paving operations. At request of Contractor, Engineer may approve a change in the dilution ratio of the water-emulsion mixture.

3.4 BITUMINOUS PAVEMENT

- A. All mixtures shall be spread and finished with a self-propelled, bituminous paver, to the required section, leaving the mixture uniformly dense, smooth, and free from irregularities.
- B. The speed of the bituminous paver shall be controlled to place the mixture uniformly and continuously without tearing or gouging. The speed shall not exceed the Manufacturer's recommendation, and shall be coordinated with the output of the plant to provide for a smooth, continuous operation, minimizing starting and stopping.
- C. Compact pavement by rolling to specified density as follows:
 - 1. Compaction shall consist of initial or breakdown rolling, intermediate rolling, and final or finish rolling with rollers meeting all requirements of NDDOT Standards Specifications and which are approved by the Engineer.
 - 2. Breakdown rolling shall consist of one or more complete coverages with a rubber tired roller.

3. Breakdown rolling shall be followed by intermediate rolling with either a rubber tired roller or a vibratory steel roller and shall be continued until the surface is tightly bound and shows no displacement under the roller.
 4. Intermediate rolling shall be completed before the mat temperature falls below 185° F.
 5. Final rolling shall be performed with a steel roller and shall continue until roller marks are eliminated. Contractor may be required to modify rolling sequence to best suit the construction conditions.
 6. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
 7. Compaction shall be a minimum of 95 percent of the daily Field Marshall Density (ASTM D-1559).
- D. Uniformly blend pavement surface into elevations at curbs, valve box castings, and other critical points of contact. Place pavement so that the pavement is ¼"-inch higher than the edge of the structure after the pavement has been compacted.
- E. All transverse and longitudinal joints, high or low areas, and surface irregularities, shall be leveled, filled, or raked prior to compaction. Any loose material dropped on previously compacted lanes shall be removed immediately.
- F. Ensure joints made during paving operations are straight, clean, vertical, and free of broken or loose material. Joints shall be tacked and constructed with adequate bond on abutting surfaces. Vertical construction joints in successive courses shall be placed so that joints do not fall on the same vertical plane.
- G. Rolling shall begin at the edges and proceed parallel to the road centerline, each trip overlapping the previous roller pass. On paving an echelon or abutting a previously placed lane, the longitudinal joint should be rolled first followed by the regular rolling procedure. Rolling shall begin at the low elevation and progress to the high elevation by overlapping of longitudinal passes, paralleling the centerline. Displacement resulting from reversing the direction of a roller or from other causes shall be corrected immediately.
- H. The sequence of rolling operations and the selection of type and number of rollers shall be commensurate with production, and shall be adequate to obtain the specified density before the mat temperature falls below 185° F.
- I. Install all bituminous pavement 3-inches and greater in thickness in a minimum of two lifts. Maximum thickness of a base course lift shall be 3-inches. Maximum thickness of a wearing course lift shall be 2 inches.
- J. Ensure surface of completed asphalt pavement is true to lines, profiles, and elevations indicated and matches existing grade.
- K. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

- L. The surfaces of previously placed layers shall be swept and a tack coat applied before spreading the next layer.
- M. The overall thickness shown on the Drawings shall be the minimum finished, in-place, compacted thickness of bituminous pavement. For patching and transition mix, match thickness of adjacent existing pavement.
- N. Protect newly paved surfaces from traffic and mechanical injury until surface has cooled to ambient temperature.
- O. Any low or high defective areas shall be corrected immediately. Corrective Work shall include patching, cutting out the surface and replacing with fresh, hot bituminous mixture, or by milling the surface.
- P. Clean up paving area.

3.5 FIELD QUALITY CONTROL

- A. Section 01 4500 – Quality Control: Field inspection and testing.
- B. Perform field and laboratory testing by an independent testing laboratory appointed and paid for by the Contractor. Field and laboratory density testing requirements are waived for projects using less than 50 tons of bituminous mix.
- C. Determine maximum density by compacting a sample of the mixture from the respective course by the laboratory Marshall compaction method, ASTM D1559, and compact each course in the field to a density not less than 95 percent of the Maximum Density attained by the Marshall Compaction method.
- D. Perform field density testing in accordance with ASTM D2950; minimum frequency of one test per 2,000 square feet per lift.
- E. Notify testing laboratory to perform density tests when testing is to be performed during construction. Do not proceed with addition Work until results have been verified.
- F. If, during progress of Work, tests indicate that compacted materials do not meet specified requirements, remove defective Work, replace, and retest. Contractor to bare all costs associated with defective pavement Work.
- G. Perform gradation analysis of aggregate once for each 500 tons of mix produced, as construction progresses.

3.6 TOLERANCES

- A. Flatness: Maximum variation of 1/4 inch measured with 10-foot straight edge.
- B. Scheduled Compacted Thickness: Within 1/4 inch of specified thickness.
- C. Variation from true elevation: Within 1/2 inch.

- D. Asphalt cement content within 0.15 percent of approved mix design as determined by daily cutoff report.

3.7 SCHEDULE

- A. Bituminous Pavement: Locations as shown on Plan Drawings. Minimum compacted thickness as shown on Typical Pavement Sections. For patching and transitions, match thickness of adjacent existing pavement.

END OF SECTION

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SECTION 32 1313**CONCRETE PAVEMENT****PART 1 GENERAL****1.1 SUMMARY****A. Section includes:**

1. Portland cement concrete pavement.
2. Concrete sidewalks, driveways, curbs and gutters, and playground curbing.
3. Reinforcement.
4. Joints and Joint Sealer.
5. Surface Finish.
6. Curing.
7. Construction requirements.
8. Materials.

B. Related Sections include, but are not limited to:

1. Section 01 1100 – Summary of Work.
2. Section 01 4500 – Quality Control.
3. Section 01 5200 – Construction Facilities.
4. Section 31 1000 – Sitework Demolition and Removal.
5. Section 31 2324 – Soil Materials.
6. Section 31 2326 – Aggregate Materials.
7. Section 31 2200 – Site Grading.
8. Section 32 0550 – Restoration of Disturbed Areas.
9. Section 32 1123 – Aggregate Base Course.

1.2 REFERENCES**A. References include, but are not limited to:**

1. North Dakota Department of Transportation (NDDOT) Standard Specifications for Road and Bridge Construction, Latest Edition.
2. American Association of State Highway Transportation Officials (AASHTO).
3. ACI 301 – Specifications for Structural Concrete Buildings.
4. ACI 304 – Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
5. ACI 305R – Recommended Practice for Hot Weather Concreting.
6. ACI 306R – Recommended Practice for Cold Weather Concreting.
7. ASTM A494 – Chemical Admixtures for Concrete.
8. ASTM A497 – Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
9. ASTM A615 – Deformed and Plain Billet-Steel for Concrete Reinforcement.
10. ASTM C33 – Concrete Aggregates.
11. ASTM C94 – Ready Mix Concrete.
12. ASTM C150 – Portland Cement.
13. ASTM C260 – Air-Entraining Admixtures for Concrete.

14. ASTM C309 – Liquid Membrane-Forming Compounds for Curing Concrete.
15. ASTM C494 – Chemical Admixtures for Concrete.
16. ASTM D1751 – Performed Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.3 SUBMITTALS FOR REVIEW

- A. See Division 01 for submittal procedures.
- B. Product Data: Furnish data on aggregates, Portland cement, air-entraining agent, admixtures and other materials and on mix design in accordance with Section 01 4500 at least 7 days prior to beginning paving operations. Engineer must approve mix formula prior to its use on Project.
- C. Samples for Verifications: For each type of exposed color, pattern, or texture indicated.
 1. Exposed Aggregate Submittals
 - a. Aggregate material to verify color and aesthetics. Provide three distinct samples sourced within 50 miles including: pea gravel, Glendive gravel, and 1 additional aggregate sample. Landscape Architect to select 2 samples for use in mock-up.
 - b. concrete surface retarder and finishing aids.

1.4 PERFORMANCE REQUIREMENTS AND QUALITY ASSURANCE

- A. Perform Work in accordance with the to North Dakota Department of Transportation (NDDOT) Standard Specifications for Road and Bridge Construction, latest edition.
- B. Batch Plant and Mixing Operations: Conform to North Dakota Department of Transportation (NDDOT) Standard Specifications for Road and Bridge Construction, Latest Edition and ACI 304.
- C. Obtain all materials from same source throughout Project.

1.5 REGULATORY AND ENVIRONMENTAL REQUIREMENTS

- A. Conform to applicable standards for paving Work on public and private property.
- B. Perform concrete paving Work in accordance with ACI 301.
- C. Conform to Section 01 5200 – Construction Facilities. Minimize interference with traffic.
- D. Perform concrete paving Work during extreme temperature conditions in accordance with ACI 305R for Hot Weather Concreting and ACI 306R for Cold Weather Concreting.
- E. Perform Work when ambient air temperature is rising and above 35 degrees F (measured in the shade and away from artificial heat). Discontinue Work when ambient air temperature is falling and reaches 40 degrees F (measured in the shade and away from artificial heat). Submit details of Contractor's means of cold weather, frost protection for newly deposited concrete to Engineer for approval.
- F. Do not place concrete when base or foundation is wet or frozen or when atmospheric conditions exist that would cause abnormal shrinking and checking of the pavement.

PART 2 PRODUCTS**2.1 FORM MATERIALS**

- A. Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when placed, impacted, and by vibration of any equipment, which they support, without spring or settlement.
- B. Except for metal forms, use new material, as needed. Previously used forms may be reused during the progress of the work, provided they are completely cleaned, reconditioned, recoated for each use, and capable of producing formwork of the required quality.
- C. For exposed concrete surfaces, provide forms that will give an aesthetically pleasing look when completed.

2.2 REINFORCEMENT

- A. All reinforcing materials and accessories shall be new, no exceptions.
- B. Reinforcing Steel: ASTM A615, 60 ksi yield grade billet steel deformed bars; uncoated finish.

2.3 CONCRETE MATERIALS

- A. Portland Cement: Conform to ASTM C150, Type I, II, or III Portland cement, gray color.
- B. Fine and Coarse Mix Aggregates: Conform to ASTM C33.
 - 1. Fine Aggregate: (Refer to Section 312326).
 - 2. Coarse Aggregate: (Refer to Section 312326).
- C. Water: Potable, not detrimental to concrete.
- D. Air Entrainment: ASTM C260.
- E. Chemical Admixture: Conforming to ASTM C494: non-chloride accelerating admixtures shall be used.
- F. Other admixtures only with the written approval of Engineer.
- G. Color: When required for LEED certification, concrete mixture shall comply with the following:
 - 1. Emissivity shall be 0.9 minimum as measured by ASTM 408.
 - 2. Initial solar reflectance (SR) shall be 0.33 minimum as measured by ASTM E903.

2.4 ACCESSORIES

- A. Joint Sealers: Polyurethane elastomeric sealant for filling joints. Acceptable products Sikaflex 2C NS/NL or approved equivalent.
- B. Concrete Curing Materials: Shall conform to the following standards:
 - 1. Cotton mats for curing concrete; AASHTO M73
 - 2. Burlap cloth made from jute or kenaf: AASHTO M182.
 - 3. Waterproof paper for curing concrete: AASHTO M139.
 - 4. Liquid membrane forming compounds for curing concrete: AASHTO M148.

5. White polyethylene sheeting (film) for curing concrete: AASHTO M171.
- C. Form Coating Materials: Shall be light commercial oil or other suitable substance that will prevent adherence of the concrete to the forms and will not reduce the strength of the concrete. In addition, the materials used for treating forms that will be in contact with concrete surfaces that are exposed to view in the finished work shall be a substance that will not appreciably affect the color of the concrete.

2.5 CONCRETE MIX - BY PERFORMANCE CRITERIA

- A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94.
- B. Provide concrete to the following criteria:
 1. Concrete Mix obtaining a minimum 28-day compressive strength of 4,000 psi and minimum 7-day and 28-day moduli of rupture (AASHTO T97) of 550 and 600 psi.
 2. Maximum water/cement ratio of 0.45.
 3. Air content between 5 and 7 percent.
 4. Maximum slump of 3-inches.
 5. Minimum cement content of 564 lbs./cubic yard.
 6. Type C Fly Ash meeting ASTM C618 may be used to replace cement on a 1:1 ratio, up to a maximum of 29 percent by weight.

2.6 EQUIPMENT

- A. Equipment and tools necessary for handling materials and performing all parts of the Work shall be sufficient as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently before the start of construction operations.

2.7 SOURCE QUALITY CONTROL AND TESTS

- A. Section 01 4500 - Quality Control: Provide concrete mix design and testing and analysis of aggregate material.
- B. Contractor shall submit samples, obtain aggregate gradation analyses, and submit for Engineer's approval. Minimum frequency for aggregate gradation analyses shall be one test per 1,000 tons of concrete mix produced or fraction thereof.
- C. Coarse Aggregate Material – Testing and Analysis: Perform in accordance with ASTM C136.
- D. Fine Aggregate Material – Testing and Analysis: Perform in accordance with ASTM C136.
- E. If tests indicate materials do not meet specified requirements, change material or material source and retest.
- F. Provide materials of each type from the same source throughout the Work.

2.8 E

- A. Spray Applied, film forming top surface retarder designed for specific sized aggregates and finish requirements. Color Coded to allow for ease of application and verification of etch level being used as well as even and complete coverage

1. Acceptable Material: Top Cast Surface Retarders by GCP Applied Technologies.
 2. Retarder Selection Guide Number / Aggregate Size to Expose / Color 01 / Light Acid Wash Finish / White 03 / Acid Etch Finish / Violet 05 / Sand Texture Finish / Lt. Blue 15 / up to ¼" agg. / Yellow 25 / 1/8" to ¼" agg / Beige 50 / 1/8" to 3/8" agg. / Canary Green 75 / ¼"-3/8" agg. / Blue 100 / 3/8" to ½" agg. / Gray 125 / 3/8" to 5/8" agg. / Pink 150 / 3/8" to 5/8" agg. / Green 200 / 5/8" to 1" agg. / Salmon 250 / 1" to 1 ½" agg. / Lt. Orange.
- B. Spray Applied and film forming protective coating for adjacent masonry and concrete surfaces
1. Acceptable Materials: Top Cast SS 100 by GCP Applied Technologies. Top Cast Surface Retarders and Top Cast SS-100 distributed by Dayton Superior Corporation. 1125 Byers Road Miamisburg, OH 45342 Dayton Superior Customer Service: 888-977-9600
www.daytonsuperior.com/products/chemicals?name=top-cast
- C. SCAQMD VOC Compliance: Contractor to submit documents that surface retarder complies with SCAQMD Rule 1113 for VOC compliance in the flats category.
- D. Dayton Superior TOP-CAST® CS 400 Cure and Seal – or approved equal. All surfacing with exposed aggregate finish shall be sealed with a transparent, non-glossy 100% acrylic (methyl methacrylate) water-based emulsion to protect and waterproof the slabs.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify existing conditions and that compacted subgrade is dry, stable, proper temperature, and compacted to specified density per Section 31 2200 and Section 32 1123. Verify subgrade elevations are correct and at proper grade to receive concrete paving. Subgrade shall be prepared as shown on the Drawings.
- B. Submit subgrade test results prior to placing concrete pavement.
- C. Verify Work of others affected has been completed and will not be adversely affected by paving operations. Verify that elevations of manhole and valve box castings in street or sidewalk are correct. Verify that curb depressions for sidewalks and driveways have been accommodated. Verify that drainage pattern matches storm water intake locations.

3.2 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Adjust valve boxes, curb stops, manhole castings, and other utility structures to grade; coat manhole, catch basin, or other frames with oil to prevent bond with concrete pavement.
- C. Notify Engineer minimum 24 hours prior to commencement of concrete delivery and placement.

3.3 FORM MATERIALS

- A. Comply with ACI 301.
- B. Curb and gutter shape shall conform to the dimensions shown on the Drawings.

- C. Concrete curb shall be recessed for handicap ramps where sidewalks cross the street.
- D. Use approved flexible forms on all curves where the radius is less than 20 times the length of the form.
- E. In the event of rain, forms shall be removed and reset as may be necessary to comply with above requirements.
- F. Clean forms prior to placement. Place and secure forms to correct size, location, dimension, profile, and gradient for sidewalk, driveway, and roadway paving thickness shown on the Drawings and for curbs and gutters.
- G. Forms shall have a height equal to the edge thickness of the sidewalk or pavement slab. Assemble formwork to fully support loading exerted by concrete placement and finishing operations without deflection, displacement, or settlement and to permit easy stripping and dismantling without damaging concrete. Forms shall be well oiled on the contact faces. Use light commercial oil or other suitable substance that will prevent adherence of the concrete to the forms and will not reduce the strength of the concrete.
- H. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required, to prevent leakage.
- I. Place no concrete until Engineer has approved subgrade and forms. Forms for paving shall be set to the proper alignment and grade for a distance equal to at least 3 hours paving time prior to Engineer approval.
- J. Moisten forms and subgrade immediately before placing concrete.
- K. Do not disturb or remove forms until the concrete has hardened sufficiently to permit removal with complete safety or unless otherwise approved by Engineer. Remove forms only during daylight hours and in a manner that avoids damage to pavement and curbs.

3.4 REINFORCING

- A. Steel Reinforcement:
 - 1. Comply with ACI 301 and placement shown on the Drawings. Reinforcement shall be clean and free of rust scale, shall be of the type, style, and dimensions shown on the Drawings.
 - 2. Place reinforcement as shown on Drawings within a tolerance of plus or minus ½ inch.

3.5 PLACING CONCRETE

- A. Preparation:
 - 1. Place no concrete until subgrade preparation, forms, and reinforcement have been inspected and approved and until elevations of castings have been verified.

2. Before placing concrete, thoroughly clean forms, wash out with water, and make tight. Sweep and wash all adjacent sidewalks next to the pour, so as to eliminate contamination from remaining debris.
3. Concrete in streets, sidewalks, parking lot, etc. are to be of the thickness as indicated on the Drawings.
4. Deposit concrete in a manner to form a continuous, full-width mass requiring a minimum of rehandling and/or redistribution and to a sufficient depth to provide excess for finishing operations.
5. Do not dump or discharge concrete on or against a joint, reinforcement, insert, embedded part, or other assembly in a manner causing displacement or damage of the assembly.
6. Before new concrete is deposited upon or against concrete that has taken its initial set or has hardened, remove all encrustations from forms and reinforcement.

B. Method of Placing.

1. Do not place concrete outside of regular working hours, unless Engineer has been notified properly and is present.
2. Do not permit concrete to drop freely more than 6 feet. The concrete shall be placed in forms by means of a chute or hand shoveling.
3. Deposit concrete so that the surface is kept level throughout, a minimum being permitted to flow from one position to another, and place as rapidly as practicable after mixing.
4. Do not use in this Work any concrete not placed within 30 minutes after leaving the mixer.
5. If concrete placement is suspended for 30 minutes or less, cover the unfinished forward face of placed concrete with wet burlap until placement operations resume. When operations resume, break down forward face of placed concrete and thoroughly merge with fresh concrete. Continue consolidations and finishing operations on placed concrete throughout suspension period.
6. Do not break or interrupt successive pours such that cold joints occur. If the suspension of concrete placement exceeds 30 minutes, a standard head joint shall be constructed; provided, however, that no header joint will be permitted within a distance of 10 feet from any adjacent transverse joint.

C. Consolidating

- a. Consolidate concrete by an approved mechanical vibrator using a uniform rate of forward progress as soon as possible after placement of concrete on subgrade. Vibrate only once thoroughly and uniformly consolidate concrete throughout its entire depth and width without damaging or displacing joint assemblies and reinforcing. Segregation of concrete or undesirable water gain in the upper pavement zone due to excessive vibration will not be permitted. Suspend vibration whenever the forward progress of the machine is interrupted. Hand-held vibratory equipment is not approved unless Contractor demonstrates that adequate manpower is dedicated to consolidation operations and Engineer approves Contractor's plan and manpower commitment in writing. Engineer may require the use of hand-held vibrators along the edge of existing pavement and curb. Suspend concrete paving if vibratory equipment failure occurs.
- b. Thoroughly work concrete around reinforcements, and embedded fixtures, and into corners of forms during placing operations.

3.6 JOINTS

- A. Intervals, type, and dimensions shown on Drawings; firmly support rebar off subgrade with chairs. Where jointing plan is not shown, prepare and furnish jointing plan for review and approval of Engineer.
- B. Construct joints straight and at right angles to pavement surface. Where practical, all joints shall align with like joints in adjoining work. Use joints to outline all panels in sidewalks, making panels square insofar as possible. Maximum joint spacing in feet shall be 1.5 times pavement thickness in inches. Maximum length of panel shall be 1.5 times width.
- C. When placing concrete adjacent to existing working joints, Contractor shall use jointing techniques that will prevent random cracking of new pavement surfaces. Techniques may include soft sawing, placing pre-molded strips, or other approved methods.
- D. After the curing period, joints to be dried and sand cleaned prior to installation of joint material; seal with hot pour or silicone material meeting requirements of the North Dakota Department of Transportation (NDDOT) Standard Specifications for Road and Bridge Construction, Latest Edition. Slightly underfill joints by approximately 1/8 inch and remove excess seal material immediately.
- E. Transverse joints:
 - 1. Match existing transverse joints.
 - 2. Saw cut 3/16 inch contraction joints to a depth of 1/4 slab depth at optimum time after finishing to prevent formation of uncontrolled cracks due to contraction of slab;
 - 3. Provide construction joints as shown on Drawings and when concrete placement is suspended more than 30 minutes; no transverse construction joints shall be allowed between normal contraction joint locations; Contractor shall lay out joint locations to ensure that construction joints do not occur at prohibited locations.
- F. Longitudinal joints:
 - 1. Match existing longitudinal joints.
 - 2. Placed as shown on Drawings; saw cut 3/16 inch contraction joints to a depth of 1/4 slab depth at optimum time after finishing to prevent formation of uncontrolled cracks due to contraction of slab.
 - 3. Construct longitudinal construction joints, if required, as shown on Drawings. The key shall be constructed by placing a deformed metal plate against the form when the first lane adjacent to the joint is placed. Remove this metal plate with the form. When placing the second slab, no concrete shall be left to overhang the lip formed on the first slab by the edging tool. Before placing the second slab, the entire edge of the first slab shall be sprayed with concrete form oil to completely break the bond between adjacent slabs.
- G. Isolation joints: use to separate thickened edge sidewalk from parking lot and adjacent curb and gutter. Joint shall be full depth of pavement and dimensions shown in Drawings; when extending full width of 5-foot wide or wider pavement, increase depth 2-inches.

1. Sidewalk isolation joints; 5/8-inch wide and full slab thickness; premolded or poured material.

3.7 FINISHING

- A. When irregularities are discovered, they shall be corrected by adding or removing concrete. The pavement surface shall have no depression in which water will stand.
- B. Ensure that paving grade has a minimum slope of 0.4 percent.
 1. Street Pavement: Finish and texture street pavement transverse to pavement centerline so that finished elevations match existing street surfaces.
- C. Brooms shall be clean and free of dry or hardened mortar.
- D. Finishing Schedules:
 1. Streets and Parking Lot: Surface shall be left slightly rough, with a uniformly tined finish. Streets shall be true to line and grade for existing concrete pavement street sections.
 2. Driveways and aprons: Light broom texture parallel to centerline of street and curb and gutter, true to line and grade. The surface shall be slightly rough but uniform.
 3. Sidewalks: Floated smooth and immediately after the water sheen disappears, broom lightly perpendicular to centerline followed by troweling joint edges. Use a clean broom at least 24 inches long and having three rows of bass, bassine, or coire fibers. Broom fibers shall be free of dry or hardened mortar from previous use.
 4. Curb and gutters: light broom.
- E. Finishing Tolerances:
 1. The true plane of the surface shall not vary more than 1/4 of an inch in 10 feet, as determined by a 10 foot straightedge placed anywhere on the slab in any direction.
 2. Produce an initial surface which is relatively free from defects, but which still may show some trowel marks.
 3. Provide a finished surface essentially free from trowel marks, uniform in texture and appearance, and in a plane of tolerance specified.

3.8 EXPOSED AGGREGATE - CONCRETE SURFACE RETARDERS

- A. Spray Applied, film forming top surface retarder, designed for specific sized aggregates and finish requirements. Color coded to allow for ease of application and verification of grade being used as well as even and complete coverage.
 1. Soon after the final seal finish has been completed spray GCP Applied Technologies "Top Cast" surface retarder using a low-pressure sprayer with a 0.5gpm tip at a rate of 200—350 sq./ft. per gallon in a full hiding coat.
 - a. Once dry GCP Applied Technologies "Top Cast" will yield a coating that provides intermittent rain protection. Once completely dry it can be covered to protect the surface if heavy extended rains are predicted.
 2. Wash surface with water rinse using stiff brooms and water hose or by high pressure washing with power equipment as early as 4-16 depending on weather conditions. Retarder removal intervals are dependent upon strength of the concrete mix, aggregate size and desired washing techniques. Earlier washing on the light etches may be necessary. Verify in accordance with the mock-up approval detailed herein.

3. Rinse water and cement matrix removal shall be in accordance with local codes and should not be allowed to be washed or flow down to arroyos, storm sewers, ponds, streams or sanitary sewers by precipitation or other surface flows.
4. Prior to completion of the project, remove wash water residue from the site to location approved by the local district.

3.9 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature curing, sun, wind, excessively hot or cold temperatures, travel, and mechanical injury. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- B. When removal of formwork occurs before concrete has totally cured, concrete shall be protected from premature drying by covering with polyethylene sheeting.
- C. Cure all horizontal surfaces with wet cure or polyethylene film.
- D. Cure concrete by covering all exposed surfaces immediately after finishing for at least 30 hours with curing paper or plastic curing blanket or by application of a liquid-membrane curing-compound.
- E. When liquid membrane curing compound is used, apply at a rate of at least one gallon per 150 square feet in two equal applications 30 minutes apart. Protect joints to be sealed from entry of curing compound.
- F. The Contractor shall insure that the concrete has developed the necessary strength before forms are removed. Apply curing compound to exposed concrete after removal of forms.
- G. Promptly repair damaged curing compounds, paper, or blankets during the 30-hour curing period.
- H. Prevent the temperature of deposited concrete from falling below 50 degrees F. until at least 30 hours of curing has taken place. Engineer may, at his/her discretion, extend this curing time for cold weather operations.
- I. Power equipment shall not operate on a pavement slab until it has attained a modulus of rupture flexural strength of 550 psi. Engineer's written approval shall be required prior to equipment access onto pavement. In the event of damage to concrete resulting from the equipment or operations, suspend operation and correct damage. Contractor shall be responsible for any damage to pavement caused by his equipment or operations, regardless of Engineer's approval.
- J. New pavement shall not be opened for traffic until the joints have been sealed. New pavement may be opened to use by the general public vehicles when the concrete has attained a modulus of rupture flexural strength of 550 psi, provided pavement is in condition for safe use.

Vehicular access limitations at colder temperatures will be extended at the Engineer's discretion; consult Engineer before allowing vehicle access.

K. Clean up paving area.

3.10 DEFECTIVE CONCRETE

- A. The following concrete will be deemed to be defective, poor in quality standards, and shall be removed and replaced promptly from the job site at no additional expense to the Owner.
1. All concrete which is not formed as indicated, is not true to intended alignment, is not plumb or level where as intended, is not true to intended grades and levels;
 2. Has voids, honeycombs, or spalling that have been cut, resurfaced, or filled, unless with the approval of the Engineer;
 3. Has uncontrolled cracks greater than 1/32 inch in width.
 4. Has sawdust, shaving, wood, dirt, rocks, or other embedded debris;
 5. The flow line surface of gutters not finished and shaped as necessary to eliminate low spots and entrapment of water;
 6. The top surface of the curbs, gutters, and curb radius shall be free from humps, sags, and other irregularities, shall be constructed to the elevations and widths shown in the Drawings and shall have edge alignment as straight as practicable on tangent sections and of uniform curvature on curved sections;
 7. Or does not conform fully to provisions of the contract documents.
- B. Repairs and Replacements:
1. Where defective concrete is found after removal of the forms, cut it out, if necessary, and make the surfaces match adjacent surfaces.

3.11 FIELD QUALITY CONTROL

- A. Section 01 4500 – Quality Control: Field inspection and laboratory testing.
1. Perform field and laboratory testing by an independent testing laboratory appointed and paid for by the Contractor.
- B. Perform one (1) field slump, one (1) air entrainment, two (2) 7-day and two (2) 28-day cylinder compression tests, and two (2) each 7-day and 28-day beam modulus of rupture tests for standard concrete in accordance with ACI 301 on the following schedule. Minimum testing frequency shall be the greater number of tests determined by the following criteria: 1) Once per day of paving operation, 2) Once per city block of paving or fraction thereof, or 3) Once per 75 cubic yards or fraction thereof. When ambient temperatures are below 45 degrees, one additional test cylinder shall be molded, cured on site under the same conditions as concrete it represents, and subsequently tested for 28-day compressive strength. Notify testing laboratory to perform tests when testing is to be performed during construction. Do not proceed with additional work until 7-day modulus of rupture results have been verified.
- C. Provide computer generated batch tickets showing the weight of each component in the concrete mixture and the batching time with each batch of concrete delivered to the project.

Contractor shall collect the batch ticket from each load delivered and shall deliver the batch tickets to the Engineer at the end of each day.

- D. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature (3 times daily), and test samples taken.
- E. If, during progress of Work, tests indicate that concrete paving materials do not meet specified requirements, remove defective Work, replace and retest. Contractor to bare all costs associated with defective pavement work.

3.12 WORKMANSHIP AND TOLERANCES

- A. Flatness: Maximum variation of measured with a 10-foot straight edge shall be $\frac{1}{4}$ inch for pavement slabs and $\frac{1}{8}$ inch for sidewalks.
- B. Scheduled thickness: Within $\frac{1}{4}$ inch of specified thickness.
- C. Variation from true elevation: Within $\frac{1}{4}$ inch.
- D. Transverse slope of surface course shall not vary from the slope shown on Drawings by more than plus or minus $\frac{1}{4}$ inch in 12 feet.

3.13 SCHEDULE

- A. Sidewalks and Shared Use Paths: As shown in details.
- B. Standard Duty Concrete Pavement: As shown in details.
- C. Curb and Gutter: As shown in details, or to match existing cross section.
- D. Patches and Repairs: Match existing concrete depths.

END OF SECTION

SECTION 32 1315**DETECTABLE WARNING SURFACE TILE****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Furnishing and installing detectable warning surface tile.
- B. Related Work:
 - 1. Section 01 4500 – Quality Control.
 - 2. Section 32 1313 – Concrete Pavement.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Shop drawings are required for products specified showing fabrication details; composite structural system; plans of tile placement including joints, and material to be used as well as outlining installation materials and procedure.
- C. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated. All test reports shall be conducted on a cast-in-place tactile tile system as certified by a qualified independent testing laboratory.
- D. Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of tactile tile and accessory as required.

1.3 QUALITY ASSURANCE

- A. Provide cast-in-place tactile tiles and accessories as produced by a single manufacturer.
- B. Installer's Qualifications: Engage an experienced Installer certified in writing by tactile manufacturer as qualified for installation, who has successfully completed tile installations similar in material, design, and extent to that indicated for Project.
- C. Americans with Disabilities Act (ADA): Provide tactile warning surfaces which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Tiles shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings and tile type shall be identified by part number.
- B. Tiles shall be delivered to location at building site for storage prior to installation.

1.5 SITE CONDITIONS

- A. Environmental Conditions and Protection: Maintain minimum temperature of 40 degrees F in spaces to receive tactile tiles for at least 48 hours prior to installations, during installation, and for not less than 48 hours after installation. Store tactile tile material in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 40 degrees F in areas where work is completed.
- B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the passengers or public. Provide barricades or screens to protect passengers or public.
- C. Disposal of any liquids or other materials of possible contamination shall be made in accordance with federal state and local laws and ordinances.
- D. Cleaning materials shall have code acceptable low VOC solvent content and low flammability if used on the site.

1.6 EXTRA STOCK

- A. Deliver extra stock to storage area designated by Engineer. Furnish new materials from same manufactured lot as materials installed and enclose in protective packaging with appropriate identification for cast-in-place tactile tiles. Furnish not less than two (2) percent of the supplied materials for each type, color, and pattern installed.
- B. guarantee
- C. Cast-in-place tactile tiles shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, and loosening of tiles.

PART 2 PRODUCTS**2.1 MATERIAL**

- A. Vitrified Polymer Composite (VPC) cast-in-place tiles shall be an epoxy polymer composition with an ultra violet stabilized coating employing aluminum oxide particles in the truncated domes. The tile shall incorporate an in-line dome pattern of truncated domes 0.2 inches in height, 0.9 inches diameter at the base, and 0.4 inches diameter at top of dome spaced 2.35 inches nominal as measured on a diagonal and 1.70 inches nominal as measured side by side.

For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90 degree raised points 0.045 inches high, per square inch.

1. Dimensions: Tiles shall be held within the following dimensions and tolerances:

Nominal Tile Size	
Length and Width: (inches)	12 x 48
Depth (inches)	1.400 ± 5%
Face Thickness (inches)	0.1875 ± 5%
Warpage of Edge (percent)	± 0.5

2. Water Absorption of Tile when tested by ASTM-D 570 not to exceed 0.35 percent.
 3. Slip Resistance of Tile when tested by ASTM-C 1028 the combined wet/dry static coefficient of friction not to be less than 0.80 on top of domes and field area.
 4. Compressive Strength of tile when tested by ASTM-D 695-91 not to be less than 18,000 psi.
 5. Tensile Strength of Tile when tested by ASTM-D 638-91 not to be less than 10,000 psi.
 6. Flexural Strength of Tile when tested by ASTM - C293-94 not to be less than 24,000 psi.
 7. Chemical Stain Resistance of Tile when tested by ASTM-D 543-87 to withstand without discoloration or staining – 1 percent hydrochloric acid, urine, calcium chloride, stamp pad ink, gum and red aerosol paint.
 8. Abrasive Wear of Tile when tested by BYK - Gardner Tester ASTM-D 2486* with reciprocating linear motion of 37± cycles per minute over a 10 inches travel. The abrasive medium, a 40 grit Norton Metallite sand paper, to be fixed and leveled to a holder. The combined mass of the sled, weight and wood block to be 3.2 lb. Average wear depth shall not exceed 0.030 after 1000 abrasion cycles measured on the top surface of the dome representing the average of three measurement locations per sample.
 9. Fire Resistance: When tested to ASTM E84 flame spread be less than 25.
 10. Gardner Impact to geometry "GE" of the standard when tested by ASTM-D 5420-93 to have a mean failure energy expressed as a function of specimen thickness of not less than 450 in. lbf/in. A failure is noted if a hairline fracture is visible in the specimen.
 11. Accelerated Weathering of Tile when tested by ASTM-G26-95 for 2000 hours shall exhibit the following result - no deterioration, fading or chalking of surface of tile.
- B. Vitrified Polymer Composite (VPC) Cast-In-Place Tiles embedded in concrete shall meet or exceed the following test criteria:
1. Accelerated Aging and Freeze Thaw Test of Tile when tested to ASTM-D 1037 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other defects.
 2. Salt and Spray Performance of Tile and Adhesive System when tested to ASTM-B 117 not to show any deterioration or other defects after 100 hours of exposure. G. Embedment flange spacing shall be 3.0 inches minimum to 3.1 inches maximum center to center spacing as illustrated on product drawing.
- C. Embedment flange spacing shall be 3.0 inches minimum to 3.1 inches maximum center to center spacing as illustrated on product drawing.

- D. Color: On City right of way, color shall be yellow conforming to Federal Color No. 33538. On private property, color shall be as selected by the Architect from manufacturer's standard colors. Color shall be homogeneous throughout the tile.

2.2 MANUFACTURERS

A. Acceptable Manufacturers:

1. Armor-Tile manufactured by Engineered Plastics Inc. (800-682-2525)
2. Approved Equal.

PART 3 EXECUTION

3.1 INSTALLATION

- A. During tile installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.
- B. Contractor shall furnish and place tile in accordance with manufacturer's recommendations and instructions.
- C. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement.
- D. Immediately after tile placement, the tile elevation is to be checked to adjacent concrete. The tile elevation and slope should be set consistent with contract drawings to permit water drainage.

3.2 CLEANING AND PROTECTING

- A. Protect placed tile until it has set completely.
- B. Protect tiles against damage during construction period to comply with tactile tile manufacturer's specification.
- C. Protect tiles against damage from rolling loads following installation by covering with plywood or hardwood.
- D. Clean tactile tiles not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean tactile tile by method specified by tactile tile manufacturer.

END OF SECTION

SECTION 32 1316**DETECTABLE WARNING SURFACE PLATE****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Furnishing and installing detectable warning surface plate.
- B. Related Work:
 - 1. Section 01 4500 – Quality Control.
 - 2. Section 32 1313 – Concrete Pavement.

1.2 SUBMITTALS

- A. Product Data: Submit manufacturer's literature describing products, installation procedures and routine maintenance.
- B. Shop drawings are required for products specified showing fabrication details; composite structural system; plans of placement including joints, and material to be used as well as outlining installation materials and procedure.
- C. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated. All test reports shall be conducted by a qualified independent testing laboratory.
- D. Maintenance Instructions: Submit copies of manufacturer's specified maintenance practices for each type of tactile plate and accessory as required.

1.3 QUALITY ASSURANCE

- A. Provide cast iron detectable warning plate and accessories as produced by a single manufacturer.
- B. Installer's Qualifications: Engage an experienced Installer certified in writing by tactile manufacturer as qualified for installation, who has successfully completed installations similar in material, design, and extent to that indicated for Project.
- C. Americans with Disabilities Act (ADA): Provide tactile warning surfaces which comply with the detectable warnings on walking surfaces section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, Part 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).

1.4 DELIVERY, STORAGE AND HANDLING

- A. Plates shall be suitably packaged or crated to prevent damage in shipment or handling. Finished surfaces shall be protected by sturdy wrappings and plate type shall be identified by part number.
- B. Plates shall be delivered to location at building site for storage prior to installation.

1.5 SITE CONDITIONS

- A. Environmental Conditions and Protection: Maintain minimum temperature of 40 degrees F in spaces to receive tactile plates for at least 48 hours prior to installations, during installation, and for not less than 48 hours after installation. Store material in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 40 degrees F in areas where work is completed.
- B. The use of water for work, cleaning or dust control, etc. shall be contained and controlled and shall not be allowed to come into contact with the passengers or public. Provide barricades or screens to protect passengers or public.
- C. Disposal of any liquids or other materials of possible contamination shall be made in accordance with federal state and local laws and ordinances.
- D. Cleaning materials shall have code acceptable low VOC solvent content and low flammability if used on the site.

1.6 EXTRA STOCK

- A. Deliver extra stock to storage area designated by Engineer. Furnish new materials from same manufactured lot as materials installed and enclose in protective packaging with appropriate identification. Furnish not less than two (2) percent of the supplied materials for each type, color, and pattern installed.

1.7 GUARANTEE

- A. Detectable warning plates shall be guaranteed in writing for a period of five (5) years from date of final completion. The guarantee includes defective work, breakage, deformation, and loosening of tiles.

PART 2 PRODUCTS**2.1 MATERIAL**

- A. Detectable Warning Plates shall be constructed of cast gray iron, ASTM A-48, Class 35B. The tile shall incorporate an in-line dome pattern of truncated domes 0.2 inches in height, 0.9 inches diameter at the base, and 0.4 inches diameter at top of dome spaced 2.35 inches nominal as measured on a diagonal and 1.70 inches nominal as measured side by side. For wheelchair

safety the field area shall consist of a non-slip surface with a minimum of 40 - 90 degree raised points 0.045 inches high, per square inch. Plates shall comply with ADA requirements for a tactile warning system.

1. Dimensions: Plates shall be held within the following dimensions:

Nominal Tile Size	
Length and Width: (inches)	24x24
Weight	62 pounds

2. Water Absorption of Tile when tested by ASTM-D 570 not to exceed 0.35 percent.
 3. Slip Resistance of Tile when tested by ASTM-C 1028 the combined wet/dry static coefficient of friction not to be less than 0.80 on top of domes and field area.
 4. Compressive Strength of tile when tested by ASTM-D 695-91 not to be less than 18,000 psi.
 5. Tensile Strength of Tile when tested by ASTM-D 638-91 not to be less than 10,000 psi.
 6. Flexural Strength of Tile when tested by ASTM - C293-94 not to be less than 24,000 psi.
 7. Chemical Stain Resistance of Tile when tested by ASTM-D 543-87 to withstand without discoloration or staining – 1 percent hydrochloric acid, urine, calcium chloride, stamp pad ink, gum and red aerosol paint.
 8. Abrasive Wear of Tile when tested by BYK - Gardner Tester ASTM-D 2486* with reciprocating linear motion of $37\pm$ cycles per minute over a 10 inches travel. The abrasive medium, a 40 grit Norton Metallite sand paper, to be fixed and leveled to a holder. The combined mass of the sled, weight and wood block to be 3.2 lb. Average wear depth shall not exceed 0.030 after 1000 abrasion cycles measured on the top surface of the dome representing the average of three measurement locations per sample.
 9. Fire Resistance: When tested to ASTM E84 flame spread be less than 25.
 10. Gardner Impact to geometry "GE" of the standard when tested by ASTM-D 5420-93 to have a mean failure energy expressed as a function of specimen thickness of not less than 450 in. lbf/in. A failure is noted if a hairline fracture is visible in the specimen.
 11. Accelerated Weathering of Tile when tested by ASTM-G26-95 for 2000 hours shall exhibit the following result - no deterioration, fading or chalking of surface of tile.
- B. Vitrified Polymer Composite (VPC) Cast-In-Place Tiles embedded in concrete shall meet or exceed the following test criteria:
1. Accelerated Aging and Freeze Thaw Test of Tile when tested to ASTM-D 1037 shall show no evidence of cracking, delamination, warpage, checking, blistering, color change, loosening of tiles or other defects.
 2. Salt and Spray Performance of Tile and Adhesive System when tested to ASTM-B 117 not to show any deterioration or other defects after 100 hours of exposure. G. Embedment flange spacing shall be 3.0 inches minimum to 3.1 inches maximum center to center spacing as illustrated on product drawing.
 3. Embedment flange spacing shall be 3.0 inches minimum to 3.1 inches maximum center to center spacing as illustrated on product drawing.
 4. Color: On City right of way, color shall be yellow conforming to Federal Color No. 33538. On private property, color shall be as selected by the Architect from manufacturer's standard colors. Color shall be homogeneous throughout the tile.

2.2 MANUFACTURERS**A. Acceptable Manufacturers:**

1. Detectable Warning Plate No. 4984 by Ironped, LLC (763-478-8128 or www.ironpad.com).
2. Approved Equal.

PART 3 EXECUTION**3.1 INSTALLATION**

- A. During plate installation procedures, ensure adequate safety guidelines are in place and that they are in accordance with the applicable industry and government standards.
- B. Contractor shall furnish and place plate in accordance with manufacturer's recommendations and instructions.
- C. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to placement.
- D. Immediately after placement, the plate elevation is to be checked to adjacent concrete. The elevation and slope should be set consistent with contract drawings to permit water drainage.

3.2 CLEANING AND PROTECTING

- A. Protect placed plate until it has set completely.
- B. Protect plates against damage during construction period to comply with tactile tile manufacturer's specification.
- C. Protect plates against damage from rolling loads following installation by covering with plywood or hardwood.
- D. Clean plates not more than four days prior to date scheduled for inspection intended to establish date of substantial completion in each area of project. Clean plates by method specified by tactile tile manufacturer.

3.3 SCHEDULE

- A. Use detectable warning plates on all locations within property boundaries of owner's site.

END OF SECTION

SECTION 32 1723**TRAFFIC CONTROL MARKINGS****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Traffic Control Pavement Markings.
 - 2. Permanent Pavement Markings.
 - 3. Other Informational Markings.
- B. Related Sections:
 - 1. Section 32 1216 – Bituminous Pavement.
 - 2. Section 32 1313 – Concrete Pavement.
 - 3. Section 32 1724 – Site Signage.

1.2 REFERENCES

- A. Manual on Uniform Traffic Control Devices (MUTCD), latest edition.
- B. North Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition

1.3 SUBMITTALS

- A. See Division 01 for submittal procedures.
- B. Product Data: Catalog cuts and manufacturer's performance data for traffic control marking and symbols.

1.4 EXISTING CONDITIONS

- A. Inspection:
 - 1. Examine area for conditions under which Work is to be performed. Report in writing to Engineer all conditions contrary to those shown on the drawings or specified herein and all other conditions that will effect satisfactory execution of work, such as improperly constructed substrates or adjoining work. Do not proceed with Work until unsatisfactory conditions have been corrected.
 - 2. Starting Work constitutes acceptance of the conditions under which Work is to be performed. After such acceptance, Contractor shall at his expense, be responsible for correcting all unsatisfactory and defective work resulting from such unsatisfactory conditions.

PART 2 PRODUCTS**2.1 MATERIALS FOR TRAFFIC CONTROL MARKINGS**

- A. Paint: Yellow, white, red, and blue NDDOT high build latex, traffic paint to meet NDDOT Specifications, water-based traffic marking paint.
- B. Apply lines and symbols as shown on Drawings.

PART 3 EXECUTION**3.1 PAVEMENT MARKING REMOVAL**

- A. Remove conflicting existing pavement markings, temporary markings, or markings put down by error as directed by Engineer.
- B. Eradication to be by high pressure water/sand slurry mixture, weather permitting. No grinding of pavement shall be allowed unless approved by the Engineer.

3.2 PREPARATION

- A. Record detailed dimensions of existing pavement markings prior to milling, overlay, or seal coat.
- B. Remove all dirt, oil, grease, and other foreign material from areas of pavement to be marked. Contractor is responsible for all preparation and layout.
- C. Apply paint only on thoroughly dry surfaces when atmospheric temperature is above 40 degree Fahrenheit and when weather is favorable.

3.3 INSTALLATION OF TRAFFIC CONTROL PAVEMENT MARKINGS

- A. Apply respective markings in colors as indicated and sizes and dimensions as indicated, or match existing colors and markings.
- B. Contractor shall replace and/or restore all pavement markings after temporary patching or Work has removed such markings.
- C. Contractor shall maintain pavement markings as required during all phases of construction.
- D. Apply painted permanent pavement markings with a maximum coverage rate of 100 square feet per gallon with a 0.015 inch minimum film thickness on bituminous and concrete paved areas, and 0.020 inch minimum film thickness on seal coated areas.
- E. Apply paint with atomizing spray type striping machine. Markings shall have clear-cut edges, true and smooth alignment, and uniform thickness. Do not permit traffic on pavement until markings are thoroughly dry. Other pavement markings shall be painted with the standard templates in an appropriate proportion.
- F. Apply respective markings in colors as indicated and sizes, locations, and dimensions as follows:
 - 1. All parking stalls to be marked with 4" wide striping, color as indicated on Drawings.
 - 2. Crosswalk markings, stop bars, and other striping shall be as indicated on Drawings.
 - 3. Pavement arrows, lettering, and symbol dimensions shall conform to MUTCD Standards.
 - 4. All handicapped parking stalls shall be marked with striping and symbols in accordance with City and ADA Standards. Handicapped stalls to include both van accessible and non-van accessible. Locations as directed by Owner, or as shown on the drawings. Color shall be blue.

- G. Contractor shall be responsible to replace and/or restore all pavement markings after temporary patching or other Work has removed such markings.

END OF SECTION

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SECTION 32 1724

SITE SIGNAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Furnishing and installation of all site regulatory and informational signage to include those identified on the plans.

1.2 RELATED WORK

- A. Section 32 1723 – Traffic Control Markings.

1.3 REFERENCES

- A. North Dakota Department of Transportation Standard Specification for Road and Bridge Construction, most recent edition.

1.4 SUBMITTALS

- A. Submittals required:
 - 1. Shop drawings on all signs, illustrating types of signs, messages and mounting.

1.5 REGULATORY REQUIREMENTS

- A. Conform to all applicable City, State, and Federal Standards for signing.

PART 2 PRODUCTS

2.1 SIGN BASE MATERIAL

- A. Sign base material for sign panels shall be sheet aluminum conforming to the material requirements of NDDOT Section 894.01A.

2.2 SIGN FACE MATERIAL

- A. Sign face material for sign panels shall be Type III retroreflective sheeting conforming to the material requirements of NDDOT Section 894.02.
- B. The colors of the panels are indicated on the Sign Schedule and shall conform to requirements of the FHWA and conform to the Color Tolerance Charts provided by the FHWA.

2.3 STANDARD CONSTRUCTION AND REGULATORY SIGNS

- A. Standard regulatory signs shall meet the requirements of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD).

2.4 FABRICATION

- A. Fabricate signs to comply with sign details and approved shop drawings, and conforming to the requirements of NDDOT Section 894.
- B. Allow for thermal expansion and contraction associated with exterior installation.

- C. Signposts and Hardware: Steel galvanized square perforated telescoping tubular posts shall conform to NDDOT Section 894.03.

2.5 POSTS AND HARDWARE FOR SIGNS

- A. The Contractor shall fabricate and install steel sign posts for all signs per NDDOT Section 894.03 and the details in the Drawings. Materials shall include the sign post, anchor, sleeve plates, shims, bolts, washers and other miscellaneous hardware required to provide a complete installation.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install signs without waves, warps, buckles, or fastening stress.
- B. Install signs straight and level. Balance signs as required. Install posts plumb.
- C. Install signs and posts in accordance with details in the drawings.
- D. Install signs to cast-in-place concrete columns or walls with at least four 3/8" lag screws and 1/4" neoprene pad washers. Provide all hardware as required.

END OF SECTION

**SECTION 32 3113
CHAIN LINK FENCES AND GATES****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Posts, rails, and frames.
- B. Manual gates with related hardware.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Requirements for concrete anchorage for posts.
- B. Section 08 7100 - Door Hardware: Gate locking device cylinder.

1.03 REFERENCE STANDARDS

- A. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
- D. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
- 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.
- F. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
- G. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
- H. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
- I. CLFMI CLF-FIG0111 - Field Inspection Guide.
- J. CLFMI CLF-SFR0111 - Security Fencing Recommendations.
- K. CLFMI WLG 2445 - Wind Load Guide for the Selection of Line Post and Line Post Spacing.
- L. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric).

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. Design Calculations: Provide calculations for fence fabric and accessory selection as well as line post spacing and foundation details. See CLFMI WLG 2445 for line post and spacing guidance.
- D. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components. See CLFMI CLF-SFR0111 for planning and design recommendations.
- E. Samples: Submit two samples of fence fabric, 6 inch by 6 inch in size illustrating construction and finish.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Fence Installer: Company with demonstrated successful experience installing similar projects and products, with not less than five years of documented experience.

- C. Design members and footings under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in the State in which the Project is located.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Master-Halco, Inc: www.masterhalco.com/#sle.
 - 2. Merchants Metals: www.merchantsmetals.com/#sle.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.

2.02 COMPONENTS

- A. Line Posts: 1.9 inch diameter.
- B. Corner and Terminal Posts: 2.38 inch diameter.
- C. Gate Posts: 3-1/2 inch diameter, or as required by gate widths indicated.
- D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- E. Gate Frame: 1.66 inch diameter for welded fabrication.
- F. Fabric: 2 inch diamond mesh interwoven wire, 9 gage, 0.1483 inch thick, top selvage knuckle end closed, bottom selvage twisted tight.
- G. Tie Wire: Galvanized steel wire.

2.03 MATERIALS

- A. Posts, Rails, and Frames: as follows:
 - 1. ASTM A1011/A1011M, Designation SS; hot-rolled steel strip, cold formed to pipe configuration, longitudinally welded construction, minimum yield strength of 50 ksi; zinc coating complying with ASTM F1043 and ASTM F1083.
- B. Line Posts: Type I round in accordance with FS RR-F-191/1D.
- C. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.
- D. Wire Fabric: ASTM A392 zinc coated steel chain link fabric.
- E. Barbed Wire Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.
- F. Barbed Wire: Zinc-coated steel, complying with ASTM A121 Type Z Coating Class 1; 2 strands of 0.099 inch diameter wire, with 4-pointed barbs at 5 inches on center.
- G. Concrete: Type specified in Section 03 3000.

2.04 MANUAL GATES AND RELATED HARDWARE

- A. Hardware for Single Swinging Gates: 180 degree hinges, 2 for gates up to 60 inches high, 3 for taller gates; locking exit device - see Door Hardware.

2.05 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.

2.06 FINISHES

- A. Components and Fabric: Galvanized in accordance with ASTM A123/A123M, at 1.7 ounces per square foot.
- B. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.
- C. Accessories: Same finish as framing.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.02 PREPARATION

- A. Removal: Obstructions or debris.
- B. Install footings in accordance with requirements of Section 03 30 00 - Cast-in-Place Concrete.

3.03 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Place fabric on inside of posts and rails.
- C. Set intermediate and terminal posts plumb. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: ASTM F567.
- E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F567.
- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail. Install brace rail one bay from end and gate posts.
- G. Provide top rail through line post tops and splice with 6 inch long rail sleeves.
- H. Do not stretch fabric until concrete foundation has cured 28 days.
- I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- J. Position bottom of fabric 2 inches above finished grade.
- K. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- M. Install bottom tension strap stretched taut between terminal posts.
- N. Install support arms sloped outward and attach barbed wire; tension and secure.
- O. Do not attach the hinged side of gate to building wall; provide gate posts.
- P. Install hardware and gate with fabric and barbed wire overhang to match fence.
- Q. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- R. Install gate locking device specified in Section 08 7100.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch.
- B. Maximum Offset From True Position: 1 inch.
- C. Do not infringe on adjacent property lines.

3.05 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Layout: Verify that fence installation markings are accurate to design, paying attention to gate locations, underground utilities, and property lines.
- C. Post Settings: Randomly inspect three locations against design for:
 - 1. Hole diameter.
 - 2. Hole depth.
 - 3. Hole spacing.
- D. Fence Height: Randomly measure fence height at ten locations or at areas that appear out of compliance with design.
- E. Gates: Inspect for level, plumb, and alignment.
- F. Workmanship: Verify neat installation free of defects. See CLFMI CLF-FIG0111 for field inspection guidance.

3.06 CLEANING

- A. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- B. Clean fence with mild household detergent and clean water rinse well.
- C. Remove mortar from exposed posts and other fencing material using a 10 percent solution of muriatic acid followed immediately by several rinses with clean water.
- D. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.07 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. Demonstrate proper operation of equipment to Owner's designated representative.
- C. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- D. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

END OF SECTION

**SECTION 32 3119
DECORATIVE METAL FENCES AND GATES****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Ornamental welded steel frame fence system.
 - 2. Swing gates.

1.02 RELATED SECTIONS

- A. Specification Section 03 3000 (Cast-In-Place Concrete)

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For fencing and gates. Drawings must be submitted for approval and be approved prior to installation.
 - 1. Include plans, post locations, gate locations, elevations, sections, and attachment details. Indicate on shop drawings all underground improvements relative to post locations.
- C. Design data which verifies compliance with design requirements specified in Performance Requirements Article.
- D. Samples: For each fence material and for each color specified.

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Product test reports.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.07 QUALITY ASSURANCE

- A. Manufacturer: Engineering and fabrication of ornamental fence systems and gate systems for a minimum of 10 years.
- B. Installer Qualifications: Installation company with experience in manufacturer's products for a minimum of 5 years. The Contractor shall provide trained laborers with prior experience in the type of construction involved as well as experience installing the materials and techniques specified.
- C. Obtain each fence system and gates through one source from a single manufacturer.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Upon delivery to the jobsite, inspect all materials for damage that might have occurred during shipment.
- B. Handle and store materials in manufacturer's packaging until materials are ready to be installed. Store materials in such a way as to prevent damage and theft.

1.09 WARRANTY

- A. Manufacturer's Warranty: Provide manufacturer's standard 20-year limited warranty, from the date of purchase, against defects in materials and workmanship including protection against cracking, peeling, blistering, and corrosion (rusting).

PART 2 PRODUCTS**2.01 MANUFACTURERS**

- A. Provide products by the following manufacturer or an approved equivalent:
 - 1. Manufacturer: FenceTrac; 11124 East Marshall Street, Tulsa, OK 74116; Tel: 918-794-8722; Email: info@fencetrac.com; Web: www.fencetrac.com.

- a. Model: FenceTrac Privacy.
- b. Style: Horizontal.
- c. Infill Material: LuxeCore Composite.
- d. Nominal Height: 8-feet.
- e. Fencing Frame Color: Black.
- f. Fencing Infill Color: To be selected by Owner's Representative from manufacturer's standard color range.

- B. Substitutions: Requests for substitutions will be considered in accordance with provisions of Section 01 6000 (Product Requirements).

2.02 PERFORMANCE REQUIREMENTS

- A. Wind Loading: Comply with ASCE/SEI 7 requirements for fence height, wind exposure, design wind speed, and design wind pressure.

2.03 DECORATIVE STEEL FENCES

- A. Steel Fence Panels constructed from steel tubing and shapes.
 - 1. Fence Framework and Posts:.
 - a. Posts: 3 by 3 inches with 12-gauge wall thickness. ASTM A924 galvanized formed and welded steel. Hot-dip galvanize steel to meet ASTM A653 and minimum coating of 0.60 oz per square foot.
 - b. Framework: ASTM A924 galvanized formed and welded steel. Hot-dip galvanize steel to meet ASTM A653 and minimum coating of 0.90 oz per square foot.
 - 1) Fabrication: Pre-cut all fence framework to specified lengths. Pre-drill post-mounted tracs for attachment to posts.
 - 2. Top & Bottom Tracs: 18-gauge steel with a cross-sectional U-Channel shape.
 - 3. Post Caps: Formed from steel sheet and hot-dip galvanized after forming.
 - 4. Style: Manufacturer's Standard Dome Cap.
- B. Infill Material: Tong-and-groove composite boards comprised of cellular PVC core encased in ASA (acrylic-styrene-acrylonitrile). Material shall be weather, fade and UV resistant.
 - 1. Size: 1 inch by 6 inch by 6 feet (nominal).
 - 2. Color: To be selected by Owner's Representative from manufacturer's standard color range.
- C. Finish for Steel Components: Polyester TGIC powder coat with a minimum thickness of 3 mils.
 - 1. Color: Black.

2.04 SWING GATES

- A. Posts: ASTM A500 galvanized formed and welded square steel tubing. 6 by 6 inches with 11-gauge wall thickness.
- B. Gate Frame: Galvanized formed and welded square steel tubing. 2 by 4 inches with 11-gauge wall thickness.
- C. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 7 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
- D. Infill Material: Tong-and-groove composite boards comprised of cellular PVC core encased in ASA (acrylic-styrene-acrylonitrile). Material shall be weather, fade and UV resistant.
 - 1. Size: 1 inch by 6 inch by 6 feet (nominal).
 - 2. Color: To be selected by Owner's Representative from manufacturer's standard color range.
- E. Finish for Steel Components: Polyester TGIC powder coat with a minimum thickness of 3 mils.
 - 1. Color: Black.

2.05 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 3000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump,

and 1-inch maximum aggregate size or dry, packaged, normal-weight concrete mix complying with ASTM C 387/C 387M mixed with potable water according to manufacturer's written instructions.

PART 3 EXECUTION

3.01 DECORATIVE FENCE INSTALLATION

- A. Install fences according to manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening rails and infill panels to posts.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 48 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
 - 3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
 - a. Crown concrete footings to shed water.
 - 4. Space posts uniformly at 6 feet o.c. (nominal).

3.02 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.03 CLEANING

- A. Remove all cutting and drilling chips that are attached the fencing, post, brackets or additions to prevent corrosion.
- B. Repair scratches and other installation-incurred damage. Using a spray paint of the appropriate color that includes a zinc additive, repaint and seal any scratches or holes drilled in the fencing, post, brackets, or additions to prevent rust from forming.
- C. Clean up debris and unused material, and remove from site.

END OF SECTION

**SECTION 32 3300
SITE FURNISHINGS****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. Section Includes:
 - 1. Seating.
 - 2. Bicycle racks.
 - 3. Trash receptacles.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified.
- C. Installer Qualifications: Submit evidence of successful installation history with comparable materials and designs specified.

1.04 COORDINATION

- A. Coordinate with site work and other appropriate sections of the specification to maintain proper provisions of the work specified.
- B. Lay out all site furnishings in the field and approved by the Owner's Representative prior to installation and permanently anchoring furnishing.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.
- B. Product Warranty: For each type of site furnishing, provide the manufacturer's written warranty.

1.06 MAINTENANCE MATERIAL SUBMITTAL

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Bench, Picnic Table, and/or Waste Receptacle Replacement Slats: No fewer than two full-size units for each size indicated.
- C. Trash Receptacle Inner Container: Two units for each size indicated.
- D. Anchors: Two units for each product type listed.

1.07 DELIVERY, STORAGE & HANDLING

- A. Deliver products to site in manufacturer's original, unopened containers and packing. Upon delivery, examine packages immediately to ensure all products are complete and undamaged.
- B. Store products in a protected, dry area in manufacturer's unopened containers and packaging until site is prepared for installation of site furnishings.
- C. Protect product finish from damage during handling and installation.

PART 2 PRODUCTS**2.01 BENCHES**

- A. Provide products from the following manufacture or approved equivalent:
 - 1. Manufacturer: Victor Stanley.
 - 2. Model: CM-324.
- B. Frame: Ductile iron, tubular steel, and solid steel.
- C. Seat and Back:
 - 1. Material:

- a. Recycled Plastic Planks: Evenly spaced, parallel.
 - b. Seat Surface Shape: Contoured or dished.
- D. Overall Length: 6-feet (nominal).
- E. Arms: Two, one at each end.
 - 1. Arm Material: Match frame.
- F. Seating Configuration: Multiple units as indicated on Drawings.
- G. Steel Finish: TGIC polyester powder coated.
 - 1. Thickness: 8 to 10 mils. Not less than 8 mils.
 - 2. Color: Black.
- H. Recycled Plastic Planks Color: To be selected by Owner's Representative from manufacturer's standard color range.
- I. Mounting: Permanently affixed to the ground according to manufacturer's written instructions.

2.02 BICYCLE RACKS

- A. Provide products from the following manufacture or approved equivalent:
 - 1. Manufacturer: Victor Stanley.
 - 2. Model: BRQS-101.
- B. Bicycle Rack Construction:
 - 1. Frame: Steel.
 - a. Tubing OD: Not less than 2-3/8 inches.
 - b. Capacity: Designed to accommodate no fewer than two bicycles.
 - 2. Security: Designed to lock wheel and frame.
 - 3. Accessories: Base covers for each pipe and tubing anchored end.
 - 4. Installation Method: Surface flange anchored at finished grade to substrate indicated.
- C. Steel Finish: TGIC polyester powder coated.
 - 1. Thickness: 8 to 10 mils. Not less than 8 mils.
 - 2. Color: Black.

2.03 TRASH RECEPTACLES

- A. Provide products from the following manufacture or approved equivalent:
 - 1. Manufacturer: Victor Stanley.
 - 2. Model: REN-36TD.
- B. Recycled Plastic Facing Surrounds: Evenly spaced recycled plastic slats.
- C. Support Frames: Steel; welded.
- D. Trash Receptacles:
 - 1. Receptacle Shape and Form: Round cylinder; with opening for depositing trash in lid or top.
 - 2. Lids and Tops: Secured by cable or chain, hinged, swiveled, or permanently secured.
 - a. Description: Rain Bonnet.
 - 3. Inner Container: Rigid plastic container with drain holes; designed to be removable and reusable.
 - 4. Disposable Liners: Provide receptacles design to accommodate disposable liners.
 - 5. Capacity: Not less than 36 gal. (nominal).
 - 6. Service Access: Removable lid or top.
 - 7. Installation Method: Surface anchored at finish grade to substrate indicated with anchors according to manufacturer's written instructions.
 - 8. Steel Finish: TGIC polyester powder coated.
 - a. Thickness: 8 to 10 mils. Not less than 8 mils.
 - b. Metal Color: Black.
 - 9. Recycled Plastic Planks Color: To be selected by Owner's Representative from manufacturer's standard color range.

- E. Plastic Liner Color: Manufacturer's standard color.

2.04 MATERIALS

- A. Steel and Iron: Free of surface blemishes and complying with the following:
1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
 2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53/A 53M, or electric-resistance-welded pipe complying with ASTM A 135/A 135M.
 3. Tubing: Cold-formed steel tubing complying with ASTM A 500/A 500M.
 4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513/A 513M, or steel tubing fabricated from steel complying with ASTM A 1011/A 1011M and complying with dimensional tolerances in ASTM A 500/A 500M; zinc coated internally and externally.
 5. Malleable-Iron Castings: ASTM A 47/A 47M, grade as recommended by fabricator for type of use intended.
 6. Gray-Iron Castings: ASTM A 48/A 48M, Class 200.
- B. Plastic: Color impregnated, color and UV-light stabilized, and mold resistant.
1. Polyethylene: Fabricated from virgin plastic HDPE resin.
- C. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or noncorrodible materials; commercial quality, tamperproof, vandal and theft resistant, concealed, recessed, and capped or plugged.

2.05 FABRICATION

- A. Metal Components: Form required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- E. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.06 STEEL AND GALVANIZED-STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
1. Minimum thickness: 8 to 10 mils, but no less than 8 mils.

2.07 IRON FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.
1. Minimum thickness: 8 to 10 mils, but no less than 8 mils.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.

- B. Unless otherwise indicated, install site furnishings after landscaping, paving, and other site work has been completed.
- C. Layout all site furnishings in the field at locations indicated on Drawings for Owner's Representative's approval prior to permanent installation. Do not permanently affix or place anchoring devices until locations are approved. Contractor assumes full responsibility for damage or resulting from the premature mounting of furnishings or anchoring devices prior to obtaining layout approval.
- D. Install site furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

END OF SECTION

**SECTION 32 8200
IRRIGATION PUMPS****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. Section includes:
 - 1. Prefabricated, skid-mounted irrigation pump station designed to deliver required flow and pressure.
The system includes:
 - a. Pump and motor.
 - b. Gauges.
 - c. Valves.
 - d. Sensors.
 - e. Controls.
 - f. Metal Enclosure.
 - g. Intake and discharge drop pipe connections.
 - h. All other required accessories and equipment required for a fully operational irrigation pumping station.
 - i. Freight from manufacturer to Project Site.
 - j. Off-loading at Project Site.
 - k. Placing and securing pump station on concrete pad.
 - 2. Installation by a factory-trained and authorized pump system technician.
 - 3. Pump station start-up and tuning by a factory-trained and authorized pump system technician.
 - 4. Operator orientation.
 - 5. Warranty.

1.03 RELATED SECTIONS

- 1. Specification Section 32 9300 "Plants" for plant stock and landscape accessories.
- 2. Specification Section 32 9200 "Turf and Grasses" for and seeding operations.
- 3. Specification Section 32 9113 "Topsoil" for topsoil operations.
- 4. Specification Section 32 8400 "Irrigation" for irrigation system and accessories.

1.04 SUBMITTALS

- A. Shop Drawings: Submit shop drawings, including skid layout, piping arrangement, equipment, and electrical panel drawings. Show products required for proper installation, their relative locations and critical dimensions. Note any modifications to the installation detail.
- B. Project Close-out: Operations and maintenance manuals and warranty certifications.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer whose work has been in at least 12 commercial or institutional irrigation systems. Installer shall be certified to by manufacturer to install and set up manufacturer's equipment.
- B. Codes and Standards: Where provisions of pertinent codes and standards conflict with the requirements of this section of these Specifications, the more stringent provisions shall govern.
 - 1. In addition to complying with all pertinent codes and regulations, comply with the latest rules of the National Electrical Code for all electrical work and materials.
 - 2. Comply with requirements of the Uniform Plumbing Code, utility supplying water and authorities having jurisdiction for preventing backflow and back siphonage.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Protection: Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installed work and materials of all other trades.

- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner's Representative and at no additional cost to the Owner.

1.07 WARRANTY

- A. Special Warranty: The pump station shall be free of defects for two-years from date of start up or 27 months after shipment. Failures caused by lightning strikes, power surges, vandalism, operator abuse, or acts of God are excluded from warranty coverage.
1. Warranty Period Services: The Contractor shall winterize the system and perform spring start-up of the system during the guarantee period. These functions shall be coordinated in advance with the Owner, and the Owner's personnel shall be encouraged to participate.

PART 2 PRODUCTS

2.01 BASIS OF DESIGN & PERFORMANCE

- A. The basis of design pump station described in this specification establishes the standard of quality, performance, and configuration required for this project. Alternative designs or substitutions shall meet or exceed the specified standards provided in this Specification.
1. Requests for substitutions will be considered in accordance with provisions of Section 01 6000 (Product Requirements).
 2. Redesign or additional work resulting from an approved substitution shall be the responsibility of the contractor and at no additional expense to the Owner.
- B. Manufacturer
1. Provide pump station by WATERTRONICS, INC. 525 Industrial Drive, P.O. Box 530, Hartland, Wisconsin 53029-0530, www.watertronics.com.
 2. Model: WaterMax, WMBV-9000-7A-15-480-3-200-90.
 3. Enclosure: Marine Grade Aluminum.
 4. Suction Pipe: 4-inch at 90-inch bury.
 5. Discharge Pipe: 4-inch at 18-inch bury.
 6. Performance: 200 Gallons Per Minute at 90 psi.
 7. Dynamic Inlet Pressure: 39 psi measured after RPZ and meter.
 8. Boost Pressure: 51 psi.
 9. Regulate Pressure: 90 psi.
 10. Horsepower: 15 HP at 3600 RPM.
 11. Power Requirement: 480V, 60Hz, 3 PHZ, 22 FLA (EST.)
 12. Pump Start: Activation automatically upon pressure drop in the irrigation mainline by recognizing flow or a remote.
 13. Additional Components:
 - a. External red light alarm / fault light.
 - b. Backflow Prevention Device: 3-inch.
 - c. Meter: 3-inch Sensus Omni C2 provided by contractor through the City of Williston.
 - 1) Provide hole or knockout in enclosure for City's endpoint system antenna wiring.

2.02 SECTION 2: PUMP AND MOTOR

- A. Pump: Electric motor driven, horizontal centrifugal with mechanical shaft seal, volute case and impeller.
1. Motor Shaft: Manufactured from high grade steel and of reduced length to increase shaft rigidity, extend bearing life, and reduce the overall length of the pump and motor assembly. The pump shaft shall be protected with a replaceable stainless steel sleeve. The pump, motor and impeller shall be removable from the back of volute case for service without disturbing the plumbing.
 2. Shaft Seal: Self adjusting mechanical type to prevent leakage and eliminate the need for a drain piping.
 3. Volute Case: Precision machined from gray cast iron and engineered to modern hydraulic standards.
 4. Discharge Connection: It shall be possible to rotate the discharge connection to any of four positions.
 5. Motor Alignment: Heavy cast iron bracket.

6. Impeller: The impeller shall be an enclosed type and balanced to provide smooth operation. The impeller shall be keyed to the shaft and locked with a special cap screw and washer.
- B. Motor: Squirrel cage induction horizontal solid shaft type.
 1. The pump impeller shall be direct mounted and keyed to the motor shaft with a stainless steel protective sleeve.
 2. The temperature rise of the motor shall be to NEMA Standard for class B or Class F insulation.
 3. Radial and thrust bearings of ample capacity to accommodate the hydraulic thrust of the pump shall be incorporated into the motor.

2.03 PIPING MANIFOLD, VALVES, GAUGES AND OTHER MECHANICAL EQUIPMENT

- A. Fabricated Piping: All fabricated piping shall conform to ASTM specifications A53 for Grade B welded or seamless schedule 40 pipe.
 1. All welded flanges shall be forged steel, slip on or weld neck type.
 2. All welded fittings shall be seamless, ASTM Specification A234, with pressure rating not less than 150 PSI.
- B. Check Valve: Cast iron bodied with a spring loaded single disc. Check valves shall be sized according to the maximum discharge flow of the pump. Pressure drop across the check valve shall not exceed 2.5 PSI at full flow. On suction lift stations the check valve will be removed and a pressure rated foot valve will be supplied to attach on the end of the suction pipe.
- C. Station Discharge Isolation Valve: Pump shall be isolated by means of a butterfly valve after the check valve and before the piping exits the station enclosure.
 1. Type: Butterfly type with ten position lever, rated for 200 PSI WOG working pressure. Trim shall include stainless steel stem, bronze or nickel coated iron streamlined disk with full faced resilient seat design to eliminate need for flange gaskets.
- D. Drain Valves: Drains shall be provided from all low points in the system and shall consist of 1/4" petcocks or ball valves.
- E. Pressure Gauges: Pressure gauges shall be located upstream and downstream of the pump for easy reading of the intake and discharge pressure.
 1. Pressure gauges shall be 304 stainless steel case and bezel construction. Gauges shall be 2-1/2" diameter, liquid filled. Pressure sensing connection shall be 1/4" NPT lower gauge connection.

2.04 ELECTRICAL CONTROLS

- A. Main Station Disconnect and Fusing: A three pole, service rated main station disconnect shall be mounted in a separate NEMA 4 enclosure outside the pump station enclosure to completely isolate the pump station electrical system from incoming power.
- B. Pump Thermal Switch: The temperature of the pump shall be sensed by a thermal switch. The thermal switch shall be located on the pump volute. Externally mounted snap disc type thermal switches will not be accepted. The thermal switch shall activate upon a temperature rise above 120 degrees Fahrenheit.
- C. Flow Sensor: Incorporate an insertion type, pulse frequency output flow sensor for continuous output to pump station controls. The flow sensor output pulse shall be conditioned and fed directly to the processor for conversion and display in Gallons Per Minute and totalize. Flow sensor accuracy shall be no less than 2% for flow velocities ranging from 1 - 30 feet per second. .
- D. Pressure Transducer: A solid state pressure transducer shall provide a noise free, linear output proportional to discharge pressure. Transducer shall be solid state, strain gauge type with integral voltage regulating and output accuracy not less than 0.5%. Transducer shall be constructed of stainless steel and rated for the maximum pump station discharge pressure.
- E. Variable Frequency Drive (VFD): IGBT based with selectable carrier frequency up to 15 KHZ. Include terminals for incoming power, motor output power and control terminals. The VFD shall generate a sine-coded, variable voltage/frequency, three-phase output for optimum speed control. The VFD shall incorporate power loss ride-through. VFD protective features shall include current limit, short circuit protection, electronic motor overload protection and ground fault protection. The VFD shall have push button programming display for easy access to operation parameters. VFD must be designed for operation in 50 degree C temperature condition.

- F. National Electrical Code (NEC) Standards: Electrical controls shall conform to National Electrical Code Standards.
- G. Programmable Logic Controller: The pump sequence controller shall be an industrial grade PLC with diagnostic LED for monitoring of discrete inputs and outputs. Not less than two additional analog inputs and outputs shall be standard for monitoring and control purposes. The PLC shall contain two communication ports for monitoring and programming purposes. The PLC shall contain an EEPROM, battery backed RAM and non-volatile memory for storage of critical configuration data.
- H. Color Touch Screen Operator Interface: 3.5" backlit LED Color Touch Screen.
 - 1. Security: Operator Interface shall have password protection to prohibit unauthorized access to certain parameters.
 - 2. The interface shall also have a built-in diagnostics function for the status of the programmable controller.
 - 3. The operator interface will be able to show current GPM and total GPM, Elapsed Run Time, and alarms
- I. Control Alarms:

2.05 CONTROL ALARMS

- A. Low System Pressure Safety Shutdown: When the station discharge pressure remains below an adjustable set point for the time called out in the Technical Specifications, the pumps will be deenergized and remain so until the alarm is manually reset. The Low Pressure alarm will be indicated on the processor display.
- B. High System Pressure Safety Shutdown: When the station discharge pressure remains above an adjustable set point for the time called out in the Technical Specifications, the pumps will be de energized and remain so until the alarm is manually reset. The High Pressure alarm will be indicated on the processor display.
- C. High Pump Volute Temperature Shutdown: If the pump volute case temperature rises above 120 degrees F for the pre-programmed time, the pump will be de energized and remain so until the alarm is manually reset. The High Temperature alarm will be indicated on the processor display.
- D. Motor Overload Shutdown: If over current condition lasts longer than the pre-programmed limit the motor will be de-energized and remain so until the alarm is manually reset. The overload alarm will be indicated on the processor display.
- E. Phase Loss: The controls will sense a phase loss on the incoming power supply. If the phase loss is for longer than the drive ride through time, the motor will be de-energized and remain so until the alarm is manually reset. The Phase Loss alarm will be indicated on the processor display.
- F. VFD Fault Shutdown: The VFD shall sense additional internal faults that will cause the VFD to shutdown for system protection. These faults will be indicated on the processor display.
- G. Lightning Arrestor: The main power supply to the pump station shall be equipped with a secondary lightning arrestor having a breakdown current rating of not less than 60,000 Amps at 14,000 Volts discharge. Power supplies 300 Volts and less shall use a 300 Volt arrestor with an 800 Volt spark-over Voltage. Power supplies up to 600 Volts shall use a 600 Volt rated arrestor with a 1,000 Volt spark-over Voltage.
- H. Corrosion Inhibiting Module: Corrosion inhibiting modules shall be installed in the main electrical control enclosure in accordance with the manufacture's recommendations.

2.06 MOUNTING BASE AND ENCLOSURE

- A. Mounting Base: Construction shall include a fabricated base assembly to support all components during shipping and to serve as the installed mounting base.
 - 1. Pump station base shall be formed from a single sheet of 1/4" plate resulting in a seamless, one-piece base with rounded edges and corners. The base shall be strategically reinforced beneath as required to provide additional support and strength. The base shall be drilled and tapped allowing the pump to be secured to the base.
 - 2. Finish: Stainless Steel, unpainted.

- B. Enclosure: Weather resistant, 14 gauge or equivalent, all metal enclosure.
 - 1. Cooling: The front side of the enclosure shall have oversized cooling vents.
 - 2. Access Door Struts: Two internally mounted gas struts that shall extend to keep the access door open.
 - 3. Access: All components are to be accessible from top and front sides with the door completely open.
 - 4. Enclosure is to be suitable for mounting to the pump station base and shall include openings for suction and discharge piping.
 - 5. Enclosure shall provide a hole or knockout suitable for wiring for water meter endpoint antenna.
 - 6. Finish: Marine Grade Aluminum, unpainted.
- C. Exhaust Fan: Located inside the pump enclosure, mounted to the enclosure lid. The exhaust fan shall be activated upon pump start and shall run until the pump stops. The fan shall be black die-cast aluminum construction with UL94V-0 rated polycarbonate propeller and rated for not less than 240 CFM. Fan motor shall be permanent split capacitor type with stainless steel ball bearings, class B insulation and automatic thermal protection.

2.07 PAINTING (PIPING)

- A. Painting shall consist of a multi step coating system which includes metal preparation, rust inhibitive baked epoxy prime coat, and a two part ultraviolet light insensitive baked polyurethane finish having total dry film thickness of not less than 5 mils. Prime coat and finish coat shall be baked at 165 degrees for not less than 30 minutes to achieve a high gloss, corrosion resistant finish. Color shall be Sandstone.

2.08 ADDITIONAL EQUIPMENT

- A. Service Disconnect: The incoming high voltage disconnect shall be supplied as a Dead Front style.
- B. Reduced Pressure Backflow Preventor: The pump station is to be supplied with a 3" Reduced Pressure Zone, (RPZ), back flow preventer. The RPZ will be Model # 880V, as manufactured by FEBCO.
- C. Water Meter: Installer / General Contractor is responsible for procuring the water meter through the City of Williston and installing the meter inside the pump station.
 - 1. Pump station manufacturer shall provide space for the water meter.
 - a. Size & Model: 3-inch Sensus Omni C2.

2.09 DROP PIPE

- A. The inlet and discharge piping system will be attached to dual 90 degree drop pipes to provide below grade connection to a suction pipe or city water supply pipe or below grade connection to a discharge main line. Drop pipe sizes, connection fitting style and depth of bury will be shown on the project drawings

PART 3 EXECUTION

3.01 SURFACE CONDITIONS

- A. Verify the inlet pressure of water service prior to manufacturing the pump station.
- B. Prior to installation of the pump station, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 - 1. Verify that pump station may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- C. Discrepancies: In the event of discrepancy, immediately notify the Owner's Representative.
 - 1. Do not proceed with manufacture or installation in areas of discrepancy until all such discrepancies have been fully resolved.
- D. Field Measurements: Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design.

3.02 INSTALLATION OF PUMP STATION

- A. General: Orient the pump station in accordance with the plans.
- B. Secure pump station on to reinforced concrete pad according to the manufacturer's written instructions.

- C. Maintain clearances as indicated on submittal drawings.
- D. Coordinate electrical services per NEC.
- E. Install water meter (procured from the City) and end point system. Verify operation of end point system.

3.03 TRENCHING AND BACKFILLING

- A. General: Perform all trenching required for the installation of items where the trenching is not specifically described in other sections of these specifications.
 - 1. Make all trenches in accordance with OSHA Requirements with sufficient width to provide free working space at both sides of the trench and around the installed item as required for gluing, joining, backfilling, and compacting while minimizing width of trenches.
- B. Depth: Trench as required to provide the elevations for the drop pipes.
- C. Correction of Faulty Grades: Where trench excavation is inadvertently carried below proper elevations, backfill with material approved by the Owner's Representative and then compact to provide a firm and unyielding subgrade to the approval of the Owner's Representative and at no additional cost to the Owner.
- D. Trench Bracing: Properly support all trenches in strict accordance with all pertinent rules and regulations.
 - 1. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind will be fully protected from damage.
 - 2. In the event of damage to such improvements, immediately make all repairs and replacements necessary to the approval of the Owner's Representative and at no additional cost to the Owner.
 - 3. Arrange all bracing, sheeting and shoring so as to not place stress on any portion of the completed work until the general construction thereof has proceeded far enough to provide sufficient strength.
- E. Removal of Trench Bracing: Exercise care in the driving and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.
- F. Grading and Stockpiling Trenched Material: Control the stockpiling of trenched material in a manner to prevent water running into the excavations.
 - 1. Do not obstruct surface drainage but provide means whereby storm and waste waters are diverted into existing gutters, other surface drains, or temporary drains.
- G. Methods: All trench excavation shall be made by open cut. During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance from the banks of the trench to avoid overloading, and to prevent slides or cave-ins. All material not required for backfill or not suitable for backfill, shall be removed from the site by the Contractor. Banks of trenches shall be kept as nearly vertical as possible, and shall be properly sheeted and braced as may be necessary to prevent caving.
 - 1. Trench widths in paved streets or in areas where proximity to other structures require vertical cuts, shall not be wider than is required for proper handling, jointing and bedding of the pipe.
 - 2. The bottom of the trenches shall be accurately graded to line and grade, and provide uniform bearing and support for each section of the pipe on undisturbed soil, at every point along its entire length. Depressions for joints shall be dug after the trench bottom has been graded, and shall be only of such length, depth and width as required for properly making the particular type joint. Care shall be taken not to excavate below the depths indicated.
 - 3. Where rock occurs in trench excavation, the rock shall be removed to a depth of six (6) inches below the established grade line, and to a width of twelve (12) inches greater than the outside diameter of the pipe to be installed in the trench.

3.04 BACKFILL

- A. Inspection: The trenches shall not be backfilled until inspection has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.
- B. Around and Over Pipe: Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 3/4 inch shall be used in backfilling around and over the installed pipe.

1. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at their option and expense provide an acceptable imported material.
 2. This backfill material shall be carefully deposited around and over the pipe in layers not more than six inches thick, loose measurement, unless otherwise permitted by the Owner's Representative, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by ASTM D698 (latest revision), until the pipe has a cover depth of at least one (1) foot.
- C. Remainder of Trench Backfill: The remaining depth of the trench shall be backfilled with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
1. Inclusion of a limited amount of stones and rocks will be permitted. Stones and rocks shall in no case be larger than 1 inch, and they shall be placed so that each piece is completely surrounded with material compacted to the density specified. The size and amount of rocks used in backfill shall be such that they will not interfere with proper compaction.
 2. This material shall be carefully deposited in layers of a thickness suitable to the equipment selected by the Contractor for proper compaction and compacted to at least 95 percent of the maximum density as determined by ASTM D698 (latest revision) under pavements and structures. The method of compaction selected by the Contractor shall not cause damage of any nature to the installed pipe. In planted areas compact to 85 percent of maximum density at optimum moisture.
 3. The use of water settlement for this portion of the trench backfilling is permissible if the specified density can be obtained and the backfill material is suitable for this type of trench compaction.

3.05 TESTING

- A. The pump station and all its component parts shall undergo a complete hydraulic and electrical test prior to shipment from the factory. Testing shall be dynamic and include operation over the entire flow range of the pump station under specified suction and net discharge pressure conditions. A plot containing actual flow, pressure, KW consumption and motor RPM shall be furnished as part of the owners manual.
- B. Field Operational Test:
1. Factory startup assistance required by manufacturer or manufacturer-certified installer, either onsite or remote per manufacturer's policy.
 2. Activate the pump station for observation, function, proper operation, and leakage.
 - a. Adjust or replace defective items to correct operational deficiencies.
 - b. Verify pump performance at design flow and head.
 - c. Simulate alarms systems.

3.06 TRAINING

- A. Provide onsite training for Owner's staff, minimum 4 hours.
- B. Training shall cover pump sequencing, manual overrides, cleaning, transducer calibration, and alarm reset.

3.07 CLEANUP AND PROTECTION

- A. Cleanup: Upon completion of the work, the entire site shall be cleared of all debris, and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workmanlike appearance. Replace all obstructions remove during construction to a condition at least equal to their existing condition.

3.08 WARRANTY PERIOD SERVICES

- A. Warranty Period Services: The Contractor shall winterize the system and perform spring start-up of the system during the guarantee period. These functions shall be coordinated in advance with the Owner, and the Owner's personnel shall be encouraged to participate.

3.09 CLOSEOUT

- A. Deliver as-built drawings and O&M manuals (printed and digital).
- B. Provide warranty documentation.

- C. Furnish list of recommended spare parts.

END OF SECTION

**SECTION 32 8400
IRRIGATION SYSTEM****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. Furnish all labor, materials, supplies, equipment, tools and transportation and perform all operations in connection with and reasonably incidental to the complete installation of the irrigation system.
- B. If quantities are provided either in these specifications or drawings, these quantities are provided for information only. It is the Contractor's responsibility to determine the actual quantities of all material, equipment and supplies required by the project and to complete an independent estimate of quantities and wastage.
- C. Related Sections include the following:
 - 1. Specification Section 32 9300 "Plants" for plant stock and landscape accessories.
 - 2. Specification Section 32 9200 "Turf and Grasses" for and seeding operations.
 - 3. Specification Section 32 9113 "Topsoil" for topsoil operations.

1.03 SUBMITTALS

- A. Deliver four (4) copies of all required submittals to the Owner's Representative within 15 days from the date of Notice to Proceed. Do not permit any irrigation system component to be brought onto the job site until it has been approved by Owner's Representative.
- B. Materials List and Manufacturers' Data: Submit manufacturers' catalog cuts, specifications and operating instructions for the irrigation components listed below. Circle, highlight or otherwise indicate the option(s) for each component with options.
- C. Pipe and Tubing Materials:
 - 1. PVC Pipe, including sleeves, PE pipe and drip distribution tubing.
- D. Pipe/Tubing Connections, Fittings and Accessories:
 - 1. PVC fittings, including but not limited to tees, elbows, unions and transition fittings; drip tubing fittings, including but not limited to barb and compression fittings; drip tubing pins (staples); drip emitters; drip flush cap/drain assembly; drip operation indicators; PVC cement; and PVC primer.
- E. Valves and Valve Boxes:
 - 1. Drip electric control valve kits; manual valves and valve boxes.
- F. Irrigation Control System and Accessories:
 - 1. Irrigation controller, direct bury control wire, splicing kits, sensor(s) and sensor(s) equipment.
- G. Shop Drawings: Submit shop drawings called for in the installation details. Show products required for proper installation, their relative locations and critical dimensions. Note any modifications to the installation detail.
- H. Project Close-out: Provide record drawings, operations and maintenance manuals, controller charts and warranty certifications as specified in Part 3.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified irrigation installer whose work has been in at least 12 commercial or institutional irrigation systems.
 - 1. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and material manufacturer's recommended methods of installation and who shall direct all work performed under this section.
- B. Codes and Standards: Where provisions of pertinent codes and standards conflict with the requirements of this section of these Specifications, the more stringent provisions shall govern.

1. In addition to complying with all pertinent codes and regulations, comply with the latest rules of the National Electrical Code for all electrical work and materials.
2. Comply with requirements of the Uniform Plumbing Code, utility supplying water and authorities having jurisdiction for preventing backflow and back siphonage.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Protection: Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installed work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Owner's Representative and at no additional cost to the Owner.

1.06 PROJECT CONDITIONS

- A. Investigate and determine available water supply pressure and flow characteristics to ensure proper operation of system as designed.

1.07 WARRANTY

- A. Special Warranty: The entire irrigation and water system shall be guaranteed by the contractor to give satisfactory service for a period of one year from date of acceptance by the Owner.
 1. Should any defect develop within the time specified above due to inferior or faulty materials or workmanship, the defect shall be corrected at no expense of the Owner.
 2. Any and all damages resulting from faulty materials or workmanship shall be repaired by the Contractor to the satisfaction of the Owner, at no cost to the Owner.
- B. Warranty Period Services: The Contractor shall winterize the system and perform spring start-up of the system during the guarantee period. These functions shall be coordinated in advance with the Owner, and the Owner's personnel shall be encouraged to participate.
 1. Upon re-energizing the system, the Contractor shall repair any leaks or breaks and shall check each head and emitter, making any adjustment necessary.

PART 2 PRODUCTS

2.01 PIPE

- A. Plastic Pipe: Provide PVC, pressure rated pipe for sizes 2-1/2 inches or less meeting the requirements of ASTM D 2241, PVC 1120 compound, SDR 21 and SDR 26. Provide plastic pipe 3 inches and larger meeting the requirements of ASTM D 1785, PVC 1120 compound.
 1. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious, wrinkles, and dents.
 2. All pipe shall be continuously and permanently marked with the following information: Manufacturer's name or trademark, size, schedule and type of pipe, working pressure at 73 degrees F. and National Sanitation Foundation (N.S.F.) approval.
- B. Plastic Pipe Fittings: Provide molded plastic pipe fittings manufactured of the same material as the pipe and shall be suitable for solvent weld, slip joint ring-tite seal or threaded connections.
 1. PVC Socket Fittings: ASTM D 2466, Schedules 40 and 80.
 2. PVC Threaded Fittings: ASTM D 2464, Schedule 80.
 3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
 4. Size slip fitting socket taper so that a dry unsoftened pipe end can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted. Only schedule 80 pipe may be threaded.
 5. When connection is plastic to metal, plastic male adaptors shall be used. The male adaptor shall be hand tightened, plus one turn with a strap wrench.
 6. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick unless otherwise indicated; full-face or ring type unless otherwise indicated.
 7. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Polyethylene Pipe: ASTM F 771, PE 4710 compound; SDR 11.5 and SDR 15.

- D. Polyethylene Pipe Fittings: Provide insert fittings for PE Pipe, ASTM D 2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.
- E. Pipe Sleeves: Provide Schedule 40 PVC pipe with solvent welded joints under pavements.

2.02 PIPE JOINING MATERIALS

- A. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.03 RISERS

- A. Spray Heads: All stationary spray heads shall have risers of high-density polyethylene plastic pipe ("funny pipe") with spiral barbed ell fittings. Minimum length of "funny pipe" shall be 12 inches.
- B. Rotor Heads: All rotor pop-up sprinklers shall have an adjustable rise assembly as shown on the contract drawings. Minimum length of the unitized swing joint shall be 12 inches.
- C. All planting bed or high grass area heads shall have minimum 6-inch pop up heads to allow water to be evenly distributed over the entire bed unrestricted by vegetation heights.

2.04 SPRINKLER HEADS

- A. Spray Heads: The sprinkler body, stem, nozzle, and screen shall be constructed of heavy-duty, ultra-violet resistant plastic with a heavy-duty stainless steel retract spring for positive pop-down and a ratcheting system for easy alignment of the pattern. The sprinkler shall have a soft elastomer pressure activated co-molded wiper seal for cleaning debris from the pop-up stem as it retracts into the case to prevent the sprinkler from sticking up and to minimize "flow-by".
 - 1. The sprinkler shall have a matched precipitation rate plastic nozzle with an adjusting screw capable of regulating the radius and flow. The sprinkler shall be capable of housing protective, non-clogging filter screens or pressure compensating screens under the nozzles.
 - 2. When indicated on the design, the spray sprinklers shall also include check valve and a pressure regulating device. The check valve shall prevent low head drainage of up to 14 feet of head. The pressure-regulating device shall prevent high pressure fogging of the nozzle stream by regulating the nozzle pressure to 30 PSI for inlet pressures from 35 to 70 PSI. Below 35 PSI the pressure loss shall not exceed 6 PSI.
- B. Rotor Heads: The full- or part-circle sprinkler shall be a single stream, water lubricated, gear drive type capable of covering a 45-to-65-foot radius at a base pressure of 60 pounds per square inch with a discharge rate of 6.1 to 12 gallons per minute.
 - 1. The sprinkler shall have a strong stainless steel retract spring for positive pop-down. The sprinkler shall have a standard check valve device capable of holding up to 10 feet of head. Pop-up height as measured from the top of the cover to the centerline of the nozzle orifice shall be at least 5 inches.

2.05 DRIP IRRIGATION COMPONENTS

- A. Drip Emitters: Barb-mounted, vortex and/or pressure compensating emitter device as indicated in the Drawings.
 - 1. Provide emitter types and quantities as shown on the Drawings.
 - 2. Operating Range: 15 psi (minimum) to 50 psi (maximum).
- B. In-Line Emitters: Flexible polyethylene tubing with factory installed pressure-compensating, inline emitters installed every 18 inches. The flow rate from each installed inline emitter shall be 0.9 gallons per hour when inlet pressure is between 20 and 60 psi. The inline emitter diaphragm shall have a pressure-regulating diaphragm with a spring action allowing it to self-rinse if there is a plug at the outlet hole. The bend radius shall be 3 inches whether bending the tubing with the natural bend of the coil or against it.
- C. Distribution Tubing: Use flexible plastic distribution tubing compatible with the emitters to direct water from emitter outlet to emission point. Length of distribution tubing shall not exceed 5 feet. Secure distribution tubing outlet with tubing stakes.
- D. Flush Cap: Provide a flush cap assembly at the end of each drip lateral pipe.

2.06 VALVES

- A. Gate Valves: All manual gate valves, sizes 2-inch and smaller, shall be all bronze double disc wedge type. All gate valves of 2-1/2-inch size or larger shall be iron body, brass trimmed, double disc wedge type, 125 PSI rated. Gate valves shall function and be equal to PGL 701-A flanged, PGL 705-A threaded, or PGL 708-A gasketed.
- B. PVC Ball Valves: Union type, with full-port ball, socket or threaded detachable end connectors, and pressure rating not less than 150 psig (1035 kPa). PVC ball valves may be used for sizes 2-1/2" and smaller, brass or bronze ball valves are required for sizes 3" or larger.
- C. Electric Control Valves: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac epoxy-sealed solenoid for commercial/institutional applications.
- D. Quick Coupler Valves: Factory-fabricated, bronze or brass, two-piece assembly; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5 NH threads for garden hose on outlet; and operating key. Provide 2 operating keys to the Owner at the completion of the project.
- E. Air Release Valve: Combination air and vacuum release valve incorporated into one single plastic valve body with an operating pressure of 1.5 to 145 psi.

2.07 VALVE BOXES

- A. General: All remote control valves, manual control valves, zone shut-off valves, gate valves or globe valve filters and drains unless otherwise indicated, shall be installed in valve access box of proper size as required for easy access to the valve.
- B. Plastic Control-Valve Boxes: Box and cover, with open bottom and openings for piping; designed for installing flush with grade. Include size as required for valves and service. Electric control valves must be placed in square valve boxes with polyethylene sidewall and cover materials. Lettering on the cover will be "IRRIGATION."

2.08 SPECIALTIES

- A. Automatic Irrigation Controller: The automatic irrigation controller shall be 117 volt input, 26.5 volt output, with the number of valve stations and in the type and model number indicated on the Drawings. Power will be provided by others.
 - 1. Provide the Owner two keys for each automatic controller at the conclusion of the project.
 - 2. Provide surge protection arrestors as recommended by the controller manufacturer.
- B. Exterior Control Enclosures: Weatherproof, with locking cover and two matching keys; include provisions for grounding and enameled-steel, sheet metal material of a freestanding type mounting system.
- C. Wireless Rain/Freeze Sensor: Sensor shall have a gradual rainfall setting adjustment from 1/8 inch to 3/4 inch with a sensing element composed of hydroscopic disks. Device shall provide a communication distance of up to 300 foot line of sight. The transmitter shall be powered by two (3V CR2032 batteries. The temperature sensor trips at 37 degrees F, with plus or minus one degree.
- D. Decoder Control Cable: Provide direct burial single conductor insulated wire control cable wire, sizes 14 AWG, utilizing low density high molecular weight polyethylene insulation, twisted, suitable for direct burial applications for operation up to 600 volts and conductor temperatures up to 60°C. UL Listed. Provide soft drawn bar copper conductors meeting the requirements of ASTM B-3 or B-8. Provide insulation thickness of 0.060 inch. Mark surface with the manufacturer's identification.
 - 1. Complete all splices within valve boxes using one-piece, jelly-filled, water-proof wire connectors with 20 expansion coils per splice. Accomplish splicing in conformance with articles 300.5 (underground installations) and 110.14 (electrical connections).
- E. Backflow Prevention: Provided within pump station enclosure.
- F. Concrete: Use class 'F' Concrete for thrust blocks and protection.
- G. All other materials, not specifically described but required for a complete and proper irrigation system installation, shall be new, first quality of their respective kinds, and subject to the approval of the Owner's Representative.

PART 3 EXECUTION**3.01 SURFACE CONDITIONS**

- A. Inspection: Prior to all work of this section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
 - 1. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer's recommendations.
- B. Discrepancies: In the event of discrepancy, immediately notify the Owner's Representative.
 - 1. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
- C. Field Measurements: Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design.

3.02 INSTALLATION OF PIPING

- A. General: Layout the piping system in accordance with the plans.
 - 1. Where piping is shown on the plans to be under paved areas but running parallel and adjacent to planted areas, the intention is to install the piping in the planted areas.
 - 2. Line Clearance: All lines shall have a minimum clearance of 4 inches from each other, and 6 inches from lines of other trades, except through pipe sleeves.
- B. Parallel lines shall not be installed directly over one another.
- C. Inspection of Pipe and Fittings: Carefully inspect all pipe and fittings before installation, removing all dirt, scale, and burrs and reaming as required; install all pipe with all markings up for visual inspection and verification.
- D. Plastic Pipe: Plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.
 - 1. All plastic joints shall be solvent-weld joints or slip seal joints. Only the solvent cement recommended by the pipe manufacturer shall be used. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the Contractor's responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The Contractor shall assume full responsibility for the correct installation.
 - 2. All plastic to metal joints shall be made with plastic male adaptors.
 - 3. The solvent-weld joints shall be made dry.
 - 4. The solvent-weld joints shall be allowed to set at least 24 hours before pressure is applied to the system on PVC pipe.
- E. Pipe Pulling: Pulling of pipe is acceptable for the installation of lateral lines only. Contractor has the option to pull or trench laterals.
 - 1. Pull pipe to the depth as required on the Drawings.

3.03 TRENCHING AND BACKFILLING

- A. General: Perform all trenching required for the installation of items where the trenching is not specifically described in other sections of these specifications.
 - 1. Make all trenches in accordance with OSHA Requirements with sufficient width to provide free working space at both sides of the trench and around the installed item as required for gluing, joining, backfilling, and compacting while minimizing width of trenches.
- B. Depth: Trench as required to provide the elevations shown on the Plans.
 - 1. Trench to sufficient depth to give a minimum of 18 inches of fill above the top of the pipe measured from the adjacent finished grade under driveways and sidewalks.
 - 2. All mainline shall have a minimum cover of 18 inches above the pipe. All laterals shall have a minimum cover of 12 inches above the pipe. All drip laterals shall have a minimum cover of 8 inches above the pipe.
 - 3. All sleeves shall be installed at a depth on line and grade with existing or proposed irrigation lines. Sleeves with excessive or shallow invert depth will be rejected.

- C. Correction of Faulty Grades: Where trench excavation is inadvertently carried below proper elevations, backfill with material approved by the Owner's Representative and then compact to provide a firm and unyielding subgrade to the approval of the Owner's Representative and at no additional cost to the Owner.
- D. Trench Bracing: Properly support all trenches in strict accordance with all pertinent rules and regulations.
 - 1. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind will be fully protected from damage.
 - 2. In the event of damage to such improvements, immediately make all repairs and replacements necessary to the approval of the Owner's Representative and at no additional cost to the Owner.
 - 3. Arrange all bracing, sheeting and shoring so as to not place stress on any portion of the completed work until the general construction thereof has proceeded far enough to provide sufficient strength.
- E. Removal of Trench Bracing: Exercise care in the driving and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.
- F. Grading and Stockpiling Trenched Material: Control the stockpiling of trenched material in a manner to prevent water running into the excavations.
 - 1. Do not obstruct surface drainage but provide means whereby storm and waste waters are diverted into existing gutters, other surface drains, or temporary drains.
- G. Methods: All trench excavation shall be made by open cut. During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance from the banks of the trench to avoid overloading, and to prevent slides or cave-ins. All material not required for backfill or not suitable for backfill, shall be removed from the site by the Contractor. Banks of trenches shall be kept as nearly vertical as possible, and shall be properly sheeted and braced as may be necessary to prevent caving.
 - 1. Trench widths in paved streets or in areas where proximity to other structures require vertical cuts, shall not be wider than is required for proper handling, jointing and bedding of the pipe.
 - 2. The bottom of the trenches shall be accurately graded to line and grade, and provide uniform bearing and support for each section of the pipe on undisturbed soil, at every point along its entire length. Depressions for joints shall be dug after the trench bottom has been graded, and shall be only of such length, depth and width as required for properly making the particular type joint. Care shall be taken not to excavate below the depths indicated.
 - 3. Where rock occurs in trench excavation, the rock shall be removed to a depth of six (6) inches below the established grade line, and to a width of twelve (12) inches greater than the outside diameter of the pipe to be installed in the trench.
- H. Pavement Removal: Where excavation of trenches requires the removal of pavement, the pavement shall be cut in a straight line along the edge of the excavation by use of a spade-bitted air hammer, concrete saw or similar approved equipment to obtain straight, square and clean break; and, after backfilling and subgrade preparations are completed, the pavement section and surfacing shall be replaced.
 - 1. Excess material, including rock, broken concrete, bituminous materials, debris or other materials not suitable for backfill, shall be removed from the site and disposed of by the Contractor.

3.04 BORING

- A. Locations: Boring shall be used to route pipe, wiring, or both under structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.
- B. Method: Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the Owner's Representative capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures.

3.05 SLEEVES

- A. Locations: Install sleeves wherever routing of a pipe, wiring, or both crosses a paved area or passes through a bored hole.
- B. Methods: Sleeves laid in open trenches shall be uniformly and evenly supported by undisturbed soil on the trench bottom. Backfill shall conform to standards hereinafter specified.

1. Sleeves installed in borings shall be forced through and have a snug fit throughout the length of the bored hole. Sleeves cracked or broken shall not be accepted.
2. Installation of pipe for sleeving shall occur where pipe lines run under or through pavements or structures and as shown on the plans. Sleeve inverts shall be laid at the grade of the lines it will carry and sloped to drain. All permanent sleeves shall be laid side by side in all locations unless noted otherwise. Inverts in and out shall be permanently marked in the field and on the as built drawings.

3.06 BACKFILL

- A. Inspection: The trenches shall not be backfilled until inspection has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.
- B. Around and Over Pipe: Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than 3/4 inch shall be used in backfilling around and over the installed pipe.
 1. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The Contractor may at his option and expense provide an acceptable imported material.
 2. This backfill material shall be carefully deposited around and over the pipe in layers not more than six inches thick, loose measurement, unless otherwise permitted by the Owner's Representative, wetted to optimum moisture content and uniformly compacted to at least 95 percent of the maximum density obtainable at optimum moisture content as determined by ASTM D698 (latest revision), until the pipe has a cover depth of at least one (1) foot.
- C. Remainder of Trench Backfill: The remaining depth of the trench shall be backfilled with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
 1. Inclusion of a limited amount of stones and rocks will be permitted. Stones and rocks shall in no case be larger than 1 inch, and they shall be placed so that each piece is completely surrounded with material compacted to the density specified. The size and amount of rocks used in backfill shall be such that they will not interfere with proper compaction.
 2. This material shall be carefully deposited in layers of a thickness suitable to the equipment selected by the Contractor for proper compaction and compacted to at least 95 percent of the maximum density as determined by ASTM D698 (latest revision) under pavements and structures. The method of compaction selected by the Contractor shall not cause damage of any nature to the installed pipe. In planted areas compact to 85 percent of maximum density at optimum moisture.
 3. The use of water settlement for this portion of the trench backfilling is permissible if the specified density can be obtained and the backfill material is suitable for this type of trench compaction.

3.07 INSTALLATION OF EQUIPMENT

- A. General: All fittings, valves, etc., shall be carefully placed in the trenches with concrete thrust blocks to be placed where required, or at angle points as shown on the plans and details.
 1. All sprinklers, having adjustable nozzles, shall be adjusted for proper and adequate distribution of the water over the coverage pattern of the sprinkler.
 2. All nozzles on pop-up sprinklers or spray heads shall be tightened after installation. All sprinklers shall be adjusted as required for the proper arc of coverage, radius, diameter and/or gallonage discharge.
 3. Provide a laminated tag indicating the zone number for each electric control valve. Secure the tag using a zip tie.
- B. Sprinkler Heads: Install sprinkler heads where indicated on the plans and in strict accordance with the manufacturer's recommendations or as necessary to provide complete uniform coverage.
 1. All heads on slopes where runoff may occur shall be installed with check valves if slope between heads exceeds 2 feet and install check valves on all pop up heads on slopes that exceed 6:1.
 2. Set all heads to final grades, accounting for sod depths and mulch.
- C. Control Wire: Bundle control wires where two or more are in the same trench. Bundle with pipe wrapping tape spaced at 10-foot intervals.

1. Provide 24-inch excess length of wire in an 8-inch diameter loop at each 90 degree change of direction, at both ends of sleeves and at 100-foot intervals along continuous runs of wiring. Do not tie wiring loop. Coil 24-inch length of wire within each remote control valve box.
2. Install common ground wire and one control wire for each remote control valve. Multiple valves on a single control wire are not permitted. Install wire parallel with and below PVC mainline pipe.

3.08 TESTING

- A. Flushing: Before backfilling the mainline, and with all control valves in place, but before lateral pipes are connected, completely flush and test the mainline and repair for all leaks; flush out each section of lateral pipe before sprinkler heads are attached.
- B. Testing: Make all necessary provisions for thoroughly bleeding the line of air and debris.
 1. Pipelines jointed with solvent-welded PVC joints must be cured at least 24 hours before testing.
 2. Subsections of mainline pipe may be tested independently, subject to the review of the Owner's Representative.
 3. Furnish clean, clear water, pumps, labor, fittings and equipment necessary to conduct tests.
- C. Hydrostatic Pressure Test:
 1. Subject mainline pipe to a hydrostatic pressure of 150 PSI for two hours. Test with mainline components installed. A 2 PSI pressure variation is allowed. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 2. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve or appurtenance. Repeat the test until the pipe passes the test.
 3. Cement or caulking to seal leaks is prohibited.
- D. Operational Test:
 1. Activate each remote control valve in sequence from controller. The Owner's Representative will visually observe operation, water application patterns and leakage.
 2. Replace defective remote control valve, solenoid, wiring or appurtenance to correct operational deficiencies.
 3. Replace, adjust or move water emission devices to correct operational or coverage deficiencies.
 4. Replace defective pipe, fitting, joint, valve, sprinkler or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited. Repeat test until each lateral passes all tests.

3.09 PAVEMENT REPLACEMENT

- A. Pavement Replacement: Pavement replacement shall utilize the same materials and design as the original pavement.

3.10 CLEANUP AND PROTECTION

- A. Cleanup: Upon completion of the work, the entire site shall be cleared of all debris, and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workmanlike appearance. Replace all obstructions removed during construction to a condition at least equal to their existing condition.

3.11 IRRIGATION MAINTENANCE

- A. Maintenance: The Contractor shall, for a period of one (1) year after completion and final acceptance of the work, maintain and repair any trench or boring settlement which may occur, and shall make suitable repairs to any pavements, sidewalks, or other structures which may become damaged as a result of settlement. All such maintenance and repair shall be at the Contractor's expense.

3.12 RECORD DRAWINGS

- A. Record Drawings: Maintain as-built drawings on site at all times. Record accurately on one set of black and white prints of the site plan all installed work including both pressure and non-pressure lines.
 1. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner.
 2. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavement, etc.). Locations shown on as-built drawings shall be kept day to day as the project is being installed. All dimensions noted on drawings shall be 1/8-inch in size (minimum).

3. Show locations and depths of the following items: Point of connection, routing of sprinkler pressure lines (dimension maximum 100 feet along routing), isolation valves, electric control valves, underground wire splices, quick coupling valves, routing of control wires, sprinkler heads, drip lines and other related equipment.
- B. Provide the Owner's Representative as-built drawings both electronically on a CD and reproducible mylars. In addition, the field set must be provided to the Owner's Representative.
- C. Controller Charts: As-built drawings must be approved by Owner's Representative before charts are prepared.
 1. Provide one controller chart for each controller supplied showing the area covered by automatic controller, of the maximum size controller door will allow.
 2. The chart is to be a reduced drawing of the actual as-built system.
 3. Chart shall be a black line print and different colored shading used to show area of coverage for each station.
 4. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic. The chart shall be mounted using velcro or equal type of semipermanent fastening device.
 5. These charts must be completed and approved prior to final acceptance of the irrigation system by the Owner. The Contractor shall be responsible for final drawing of these charts including reproduction and mounting.
- D. Operation and Maintenance Manuals: Prepare and deliver to the Owner's Representative within ten calendar days prior to completion of construction, all required and necessary descriptive material in complete detail and sufficient quantity, properly prepared in two individually bound copies of the operations and maintenance manual. The manual shall describe the material installed and shall be in sufficient detail to permit operating personnel to understand, operate and maintain all equipment. Spare parts lists and related manufacturer information shall be included for each equipment item installed. Each complete, bound manual shall include the following information.
 1. Index sheet stating Contractor's address and telephone number, duration of guarantee period, list of equipment with names and addresses of local manufacturer representatives.
 2. Complete operating and maintenance instructions on all major equipment.
 3. System start up and shut down instructions.
 4. In addition to the above maintenance manuals, provide the maintenance personnel with instructions for system operation and show written evidence to the Owner at the conclusion of the project that this service has been rendered.

END OF SECTION

**SECTION 32 9113
TOPSOIL****PART 1 GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

1.02 SUMMARY

- A. Section includes:
1. Topsoil for seeding plant stock.
- B. Related Sections:
1. Section 31 1000 "Site Clearing" for topsoil stripping and stockpiling.
 2. Section 31 2000 "Earth Moving" for excavation, filling and backfilling and rough grading.
 3. Section 32 9200 "Turf and Grasses" for planting soils.
 4. Section 32 9300 "Plants" for planting soils.

1.03 SUBMITTALS

- A. Imported Topsoil Analysis: Furnish soil analysis to the Owner's Representative by a qualified soil-testing laboratory stating percentages of organic matter, gradation of sand, silt and clay content; cation exchange capacity; sodium absorption ratio, deleterious material, pH and mineral and plant-nutrient content of topsoil.
- B. Topsoil Source: Submit the proposed topsoil source(s) as soon as possible after the contract award. Topsoil from proposed sources may be used only after sample tests show the material is acceptable.
- C. Noxious Weed Free Status: Prior to bringing any imported topsoil on site, provide to the Owner's Representative, certification stating that the source of the topsoil is noxious weed seed free.

PART 2 PRODUCTS**2.01 IMPORTED TOPSOIL CLASSIFICATION AND FERTILITY**

- A. Imported Topsoil Classification: Provide imported topsoil with a textural classification of loam, sandy loam or silty loam.
- B. Imported Topsoil Fertility: Provide imported topsoil that is sufficiently fertile to sustain normal healthy plant growth. Amendments and fertilizers may be required to allow the topsoil to meet these requirements and shall be incorporated into all topsoil fill by rototilling or other approved means.

<u>Parameter</u>	<u>Minimum</u>	<u>Maximum</u>	<u>Optimal</u>
pH	5.5	8.4	6.5
Nitrates (mg/kg)	1.0	150	20
Organic Matter (%)	1.0	10.0	>3.0
Olsen Phosphorus (mg/kg)	1.0	150	>50
Potassium (mg/kg)	100	1,500	>500
Sodium (meq/100g)	n/a	2.0	<1.0
Calcium (meq/100g)	0.2	5.0	>0.3
Sulfate (mg/kg)	1.0	1,500	>20
Conductivity (mmhos/cm)	n/a	2.0	<1.0
Lime (qualitative)	n/a	Moderate	Slight

2.02 TOPSOIL SOURCE

- A. Surface Soil Stockpiled On-site: Verify suitability of stockpiled surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps larger than 1-inch, and other extraneous materials harmful to plant growth. Amend stockpiled soil as necessary to achieve nutrient levels adequate to support healthy plant growth.

- B. Imported Topsoil: Import topsoil when sufficient quantities cannot be retained from the site. Do not obtain topsoil from wetland areas. Imported topsoil must be free of stones one inch or larger in any dimension and free of other extraneous materials or construction debris that is harmful to plant growth.

PART 3 EXECUTION

3.01 FINE GRADING

- A. Fine grade all topsoil areas to the lines, grades and elevations specified. Note areas to receive organic or mineral mulch or sod and adjust grades accordingly. Do not place topsoil until the designated areas are prepared and all construction work in the area is completed.
- B. Remove and dispose of all clods, rocks, large roots, litter, construction debris and all other foreign material from the topsoil before placement.

3.02 TOPSOIL DEPTH

- A. Seeding Areas: Provide a 6-inch depth of topsoil in all areas to receive seed.
- B. Planting Bed Areas: Provide a 12-inch depth of topsoil in all planting bed areas.

3.03 COMPACTION

- A. Compact all areas to receive seed or plantings to 85 percent proctor density.

END OF SECTION

**SECTION 32 9200
TURF AND GRASSES****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Seeding.

1.02 DEFINITIONS

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 9113 "Topsoil" and drawing designations for planting soils.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
 - 1. Certification of each seed mixture for turfgrass sod.
- B. Product certificates.

1.05 ACTION SUBMITTALS

- A. Seed Bag Labels: Provide a seed bag label (bag tag) for each bag of seed mixture that is used on site.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and wetland meadow during a calendar year. Submit before the expiration of required maintenance periods.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 2. Pesticide Applicator: State licensed, commercial.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

1.09 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: April 15 to May 15, or when soil temperatures are consistently greater than 50-degrees F at 2-inch depth.
 - 2. Fall Planting (Preferred Window): September 1 to September 30.
 - 3. Summer Planting: May 16 to August 31 is permitted only for irrigated seed mixtures.
 - 4. Dormant Seeding: May be permitted with written approval from the Owner's Representative and shall occur after soil temperatures are consistently below 40-degrees F and prior to sustained snow cover.

- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

PART 2 PRODUCTS

2.01 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Quality: Provide seed that has been tested for purity and germination within 12 months of the planting date. Seed of grass species as listed below, with not less than 85 percent germination, not less than 95 percent pure seed, not more than 3 percent "other crop" seed, not more than 5 percent inert matter, and not more than 0.5 percent weed seed.
1. The total percentage of crop seed, weed seed, and noxious weed seed combined shall not exceed 5 percent.
- C. Seed Mix 1: Commercially available as "Endure Brand Turf Mixture" from Agassiz Seed & Supply, or an approved equal. Proportioned by weight as follows:
1. 70% Fine Leaf Turf Type Tall Fescue
 2. 10% Kentucky Bluegrass
 3. 10% Fine Leaf Perennial Ryegrass
 4. 10% Creeping Red Fescue

Drill seed at a rate of 12 pounds per 1,000 square feet.

- D. Seed Mix 2: Custom designed by Agassiz Seed & Supply, #QUO85152, or an approved equal. Proportioned by weight as follows:
1. 18.8% (6.3 PLS / AC) Rosana Western Wheatgrass
 2. 9.0% (3.0 PLS / AC) Dacotah Switchgrass
 3. 9.0% (3.0 PLS / AC) Killdeer Sideoats Grama
 4. 9.0% (3.0 PLS / AC) Revenue Slender Wheatgrass
 5. 9.0% (3.0 PLS / AC) Garrison Creeping Foxtail
 6. 9.0% (3.0 PLS / AC) Rival Reed Canarygrass
 7. 6.6% (2.2 PLS / AC) Lodorm Green Needlegrass
 8. 29.9% (10.0 LBS / AC) DOT Cover Crop Oats

Drill seed at a rate of 35.5 pounds per acre.

2.02 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.03 MULCHES

- A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

2.04 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 EXECUTION**3.01 TURF AREA PREPARATION**

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 32 9113 "Topsoil."
- B. Reduce elevation of planting soil by ½-inch.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.02 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
 - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
 - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rates indicated in Part 2 of this Specification.
- C. For areas that cannot be mechanically sowed, broadcast seed at double the rate indicated in Part 2 of this Specification.
- D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- E. Protect seeded areas from hot, dry weather or drying winds by applying cellulose wood fiber mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.03 IRRIGATED TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to height of 2 to 3-inches without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.
- C. Turf Postfertilization: Apply slow-release fertilizer after initial mowing and when grass is dry.
 - 1. Use fertilizer that provides actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

3.04 SATISFACTORY IRRIGATED TURF

- A. Turf installations shall meet the following criteria as determined by Owner's Representative:
 - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.05 RIPARIAN TURF MAINTENANCE

- A. Maintain and establish wetland turf by watering, weeding, mowing, trimming, replanting, and performing other operations as required to establish a healthy, viable meadow. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
 - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
 - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and meadow-watering equipment to convey water from sources and to keep turf uniformly moist.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water turf with fine spray at a minimum rate of 1/2 inch per week for six weeks after planting unless rainfall precipitation is adequate.

3.06 MAINTENANCE SERVICE

- A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Irrigated Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
 - 1. Seeded Turf: 60 days from date of Substantial Completion.
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
- B. Riparian Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Riparian Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.
 - 1. Maintenance Period: 60 days from date of Substantial Completion.

END OF SECTION

SECTION 32 9219**SEEDING****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Preparation of subsoil.
 - 2. Placing topsoil.
 - 3. Seeding, mulching and fertilizer.
 - 4. Maintenance.

1.2 RELATED REQUIREMENTS

- A. Section 31 2200 - Grading: Topsoil material.
- B. Section 31 2200 - Grading: Preparation of subsoil and placement of topsoil in preparation for the work of this section.

1.3 DEFINITIONS

- A. Weeds: Include Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Topsoil Borrow: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments to become homogeneously blending mineral soil. This topsoil is used for all turf areas.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing topsoil.

1.4 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

1.5 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

- B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.1 SEED MIXTURE

- A. Seed Mixture: Seed Class II as specified in Section 251 of NDDOT Standard Specifications, latest edition.

2.2 SOIL MATERIALS

- A. Existing Topsoil: Excavated from site, stockpiled, free of weeds.

2.3 ACCESSORIES

- A. Commercial Fertilizer: Standard formula 10-6-4, nitrogen 10 percent, phosphoric acid 6 percent, potash 4 percent and shall contain minor trace elements. The formula shall be in conformity with applicative state fertilizer laws. Fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the project site in the original unopened containers, each bearing the manufacturer's guaranteed analysis.
- B. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that prepared soil base is ready to receive the work of this Section.

3.2 PREPARATION

- A. In areas which have been disturbed and need to be seeded, fine grade to smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions as required to meet finish grades.
- B. In areas which have not been disturbed and need to be seeded, till the soil to a depth of 6 inches soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.

3.3 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply fertilizer to all lawn areas to be seeded at the rate of 10 lb. per 1,000 square feet. Apply in two operations while distributing fertilizer in a perpendicular path to previous application.
- C. Apply after smooth raking of topsoil.
- D. Fertilizer shall be applied within 10 days of seeding.
- E. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- F. Mix thoroughly into upper 2 inches of topsoil.

- G. Lightly water to aid the dissipation of fertilizer.

3.4 SCHEDULING

- A. Planting Restrictions: Plant stockpile and drainage swale areas within seven (7) days of completion of grading activities.
 - 1. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

3.5 SEEDING

- A. Seeding shall be done on a still day, using a hopper type seeder, one-half of the seed for each area being sown in a direction at right angles to the other half.
- B. Apply seed at a rate of five lbs. per 1000 square feet (220 lbs. per acre) exercising great care that a uniform distribution of seed is obtained. Rake in lightly after seeding.

3.6 PROTECTION

- A. Identify seeded areas with stakes and string around area periphery. Set string height to 42 inches.
- B. Space wooden stakes at 40 feet on center, install more if steep or uneven ground exist.

3.7 MAINTENANCE

- A. Provide maintenance of seeded areas for three months from date of planting, excluding the period from October 15 to April 15.
- B. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- C. Water to prevent grass and soil from drying out.
- D. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- E. Immediately reseed areas that show bare spots.
- F. Protect seeded areas with warning signs during maintenance period.

3.8 CLEAN-UP & ACCEPTANCE

- A. Protect adjoining pavements, walks, structures from dirt and staining during completion of work.
- B. Removal of such dirt and staining is required.
- C. Leave site free of debris from this Section of Work.
- D. Protect completed seeded areas from any damage until project is accepted by Owner.
- E. All ground areas disturbed as a result of planting operations shall be restored to their original condition or to the desired new appearance.

3.9 SCHEDULE

- A. Seed all disturbed areas, including staging areas, stockpiles, drainage swales, and edge slopes of building pad.
- B. Area not required to be seeded includes building pad.

END OF SECTION

**SECTION 32 9300
PLANTS****PART 1 GENERAL****1.01 SUMMARY**

- A. Section Includes:
 - 1. Plants.
 - 2. Mulches.
 - 3. Weed Control Barrier.
 - 4. Landscape Edgings.
- B. Related Requirements:
 - 1. Section 32 9200 "Turf and Grasses" for seeding material.

1.02 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- C. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 32 9113 "Topsoil" for drawing designations for planting soils.
- D. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

1.03 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples of each type of mulch.

1.05 INFORMATIONAL SUBMITTALS

- A. Product source and procurement certificates.
- B. Product certificates.
- C. Sample warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.07 QUALITY ASSURANCE

- A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 1. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- B. Handle planting stock by root ball.

1. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.09 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
 1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
 - b. Structural failures including plantings falling or blowing over.
 2. Warranty Periods: From date of Substantial Completion.
 - a. Treed and Shrubs: 12 months.
 - b. Perennials and Ornamental Grasses: 6 months.

PART 2 PRODUCTS

2.01 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
- B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.02 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
 1. Size: 21-gram tablets.
 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

2.03 MULCHES

- A. Tree Ring Organic Mulch: Shredded hardwood.
- B. Planting Bed Mineral Mulch: Crushed stone or Gravel with no fines.
 1. Size Range: 1-1/2 inches, 3/4 inch minimum.
 2. Color: Readily available natural gravel color range.

2.04 WEED-CONTROL BARRIERS

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz/sq. yd. minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

2.05 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.06 LANDSCAPE EDGINGS

- A. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B 221, Alloy 6063-T6, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.
 1. Edging Size: 3/16 inch thick by 5-1/2 inches deep.

2. Finish: Mill (natural aluminum).

PART 3 EXECUTION

3.01 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to section 32 9113 "Topsoil."
- B. Placing Planting Soil: Place planting soil, as specified in Section 32 9113 "Topsoil," in-place over exposed subgrade.
- C. Before planting, obtain Owner's Representative's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.02 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
 2. Excavate approximately three times as wide as ball diameter.
 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.

3.03 TREE & SHRUB PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.
 1. Backfill: Planting soil as specified. For trees, use excavated soil for backfill.
 2. Balled and Burlapped Stock: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
 3. Balled and Potted and Container-Grown Stock: Carefully remove root ball from container without damaging root ball or plant.
 4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 5. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
 - a. Quantity: As indicated on Drawings.
 6. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.04 TREE AND SHRUB PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.

- B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

3.05 ORNAMENTAL GRASS & PERENNIAL PLANT PLANTING

- A. Set out and space ornamental grass and perennial plants as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.06 PLANTING AREA MULCHING

- A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 6 inches and secure seams with galvanized pins.
- B. Mulch backfilled surfaces of planting areas and other areas indicated.
 - 1. Trees in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.
- C. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of organic mulch and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.07 EDGING INSTALLATION

- A. Aluminum Edging: Install aluminum edging where indicated according to manufacturer's written instructions. Anchor with aluminum stakes spaced approximately 36 inches apart, driven below top elevation of edging.

3.08 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.09 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- F. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

3.10 MAINTENANCE SERVICE

- A. Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
 - 1. Maintenance Period for Trees and Shrubs: 12 months from date of Substantial Completion.
 - 2. Maintenance Period for Ornamental Grass & Perennial Plants: Six months from date of Substantial Completion.

END OF SECTION

SECTION 33 0513**PRECAST CONCRETE PIPE STRUCTURES, MANHOLES, AND COVERS****PART 1 GENERAL****1.1 SUMMARY****A. Section Includes:**

1. Modular precast concrete manhole sections with tongue-and-groove joints; manhole, lift station, and valve manhole access covers; anchorage; and accessories.

B. Related Sections include:

1. Section 01 3000 – Submittals.
2. Section 02 2222 – Excavating.
3. Section 02 2223 – Backfilling.

C. REFERENCES

1. Reference Standards include:

- a. ASTM A48 – Grey Iron Castings.
- b. ASTM C443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
- c. ASTM C478 – Precast Reinforced Concrete Manhole Sections
- d. ASTM C76, Class IV - Precast Reinforced Concrete Pipe Sections for Lift Station.
- e. ASTM C923 – Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
- f. ASTM GS11A – Aluminum Alloy for Access Frames and Covers.

1.2 SUBMITTALS FOR REVIEW

- A. Section 01 300 – Submittals: Procedures for submittals.
- B. Shop Drawings: Indicate manhole locations, elevations, piping and conduit, and sizes and elevations of penetrations.
- C. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.

1.3 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.4 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.

1.5 QUALITY ASSURANCE - DESIGN CRITERIA:

- A. All precast structures and components shall be designed under the direct supervision of a Professional Engineer registered in the State of North Dakota and fully experienced in design of precast concrete structural units. All precast structures and units shall be submitted during the shop drawings review process and bear the Registered Professional Engineer's Stamp and signature.
- B. Concrete dead load at 150 lbs./cf minimum. Design precast concrete units in accordance with ACI 318, under direct supervision of Professional Engineer registered in the State of North Dakota and fully experienced in design of precast concrete structural units.
- C. Design precast units and members to withstand their own weight, design loads due to the pressure and suction of wind, erection, handling and transportation forces, and all live and dead loads in accordance with applicable codes.
- D. Design component connections to provide for foundation settlement, chamber, and deflection without creating adverse reactions to other building materials or components.
- E. Steps and ladders shall be designed in accordance with ASTM C478-83, including but not limited to:
 - 1. Minimum design live load shall be a single concentrated load of 300 lbs.
 - 2. Steps in all sections shall be aligned in each section so as to form a continuous ladder with rungs equally spaced vertically in the assembled manhole at maximum design distance of 12 in.

PART 2 PRODUCTS**2.1 GENERAL**

- A. Air Release Structures, Manhole Sections, bases, and top sections:
 - 1. All structures shall be designed by a Registered Engineer in the state of North Dakota.
 - 2. Reinforced precast concrete as outlined in ASTM C478 able to withstand H-20 loading and backfill requirements; including knockouts for wall pipes as shown on Drawings. Concrete shall be Type 5 Portland cement per ASTM C150 with minimum 28-day compressive strength of 4,000 psi.
 - 3. Reinforcement: Reinforce with deformed billet-steel conforming to ASTM A615 or deformed welded wire fabric conforming to ASTM A496 and ASTM A497 for the anticipated loading conditions.
 - 4. Welded Wire Fabric: Conforming to ASTM A185.
 - 5. Prestressing Strand: Uncoated, 7-wire, stress relieved strand conforming to ASTM A416 (including supplement) - Grade 270K, low relaxation type.
 - 6. Connecting and Supporting Devices: Plates, angles, items cast into concrete, insets, bolts and accessories, conforming to ASTM A36. All items cast into precast concrete to be prime painted.
 - 7. Welded Studs: Conform to AWS D1.1.
 - 8. Admixtures:

- a. Air entraining admixtures: ASTM C260.
- b. Water reducing, retarding, accelerating, high range water reducing admixtures: ASTM C494.

2.2 PRECAST CONCRETE UNITS

- A. Manhole Sections: Reinforced precast concrete as outlined in ASTM C478 able to withstand water loading requirements; including knockouts for wall pipes as shown on Drawings.
- B. Circular Sections: Reinforced precast concrete outlined in ASTM C76 Class IV, double cage steel reinforcement, including knockouts for wall pipes and tie bolts.
- C. Manholes shall be sized appropriately for piping size, type, and locations in accordance with manufacturer's recommendations.

2.3 JOINTS

- A. Precast concrete unit riser section joints shall be tongue and groove with rubber "O" ring joint gaskets. Profile joint gaskets may be used if reviewed and approved by Engineer.
- B. Precast concrete unit joints shall be formed entirely of concrete employing a circular cross section gasket, Press Seal, or equal. When assembled, the joint shall be self-centering and make a uniform watertight joint conforming to the requirements of ASTM C443.
- C. Joints shall also be sealed with a bituminous mastic joint sealing compound, Kent Seal No. 2, by Hamilton Kent Manufacturing Co., or equal.
- D. Provide external joint seal on all manhole section joints. External joint seal shall be a 12 inch wide heavy bitumastic coating, Infi-Shield Seal Wrap, by Sealing Systems Inc., or equal.

2.4 BOTTOM SLAB SECTIONS

- A. Bottom slab sections shall be precast concrete conforming to ASTM C478 and bottom slabs shall be suitable for depth and groundwater conditions encountered.
- B. Inverts shall be formed as an integral part of the precast bottom and constructed as shown on the Drawings and shall have a smooth commercial finish.
- C. Preformed bases shall have spaces filled with the appropriate sealer.
- D. Where there are changes in the direction of the flow or entering branches into the unit, the centerline of the invert shall have a true curve of as large a radius as the size of the manhole will permit. A minimum fall of 0.10 foot shall be provided through all manholes.
- E. The inside bottom of each unit shall be shaped with concrete to form a free flow channel through invert troughs.

2.5 TOP SLAB SECTIONS

- A. Top slab sections shall be precast concrete conforming to ASTM C478. Top slabs shall be suitable for H20 wheel loading.
- B. Commercial finish formed surfaces and broom finish top surface.
- C. Provide tapered handling hooks as required.
- D. Access hatches and or vent pipes shall be cast integral with the slab where required as shown on the Drawings.

2.6 MANHOLE STEPS

- A. Where called for on the Drawings, provide plastic steps placed at 12" spacing. Steps shall comply with ASTM C-478 and OSHA.
- B. Whenever possible, steps shall not be placed directly above the manhole flow channel. Steps should be located above the largest bench area in the manhole base. Steps shall be equally spaced, 12-inches on center maximum, for the entire depth of the manhole.

2.7 GRADE ADJUSTMENT RINGS

- A. Grade adjustments of manhole frame and cover assemblies shall be completed utilizing HDPE adjusting rings, standard two-inches thick. Each new manhole shall have a total height of adjustment between four (4) and six (6) inches, unless otherwise directed by ENGINEER.
- B. Precast reinforced concrete grade adjustment rings shall conform to ASTM C378 and shall be free from cracks, voids, and other defects.
- C. The diameter or rectangular dimension of rings shall conform to the type of casting on the structure.
- D. Provide grout or mortar between the rings.
- E. Wrap adjusting rings, edge of casting frame, and upper barrel section (where applicable) with Infishield, or Cretex™ External Manhole Chimney Seal, approved flexible sealing product per manufacturers specs.

2.8 MORTAR

- A. Mortar shall conform to ASTM C270. The cement shall be Type S masonry cement .
- B. Water shall be added for proper consistency. The entrained air content of the mortar shall range between seven (7) to ten (10) percent.
- C. Mortar sand volume shall equal 2.25 to 3.00 times the total volume of cement and lime.

2.9 PIPE CONNECTIONS TO MANHOLES

- A. Pipe to manhole connections on all pipes shall be flexible and watertight. Pipe shall be sealed in the manhole section pipe openings with a resilient connector meeting the requirements of ASTM C923. The connection may be of the following types:

1. Rubber sleeve with stainless steel banding type, Press Seal PSX, A-Lok G3, or equal. Install by mechanical means in openings cut into manhole wall per ASTM C923.
 2. Cast in place rubber gasket with stainless steel banding type, Press Seal Cast A Seal, or equal. Resilient connector shall be cast integrally into the wall of the manhole section at time of manufacture.
- B. Pipe to manhole connections shall utilize link seal where indicated on the drawings.

2.10 ACCESSORIES

A. Manhole Access Frames and Covers:

1. Standard Casting: ASTM A48, Class 35B Gray (cast) Iron construction machined flat bearing surface, removable lid.
2. Manufacturer and Products
 - a. Standard Manhole: Neenah Model R-1915, East Jordan V1827, or approved equal.

B. Manhole Hatches

1. 1/4 inch thick 6061-T6 aluminum alloy, ASTM GS11A, diamond pattern plate access cover; slam lock with removable key wrench.
2. Coordinate Lift Station access frame and cover size, orientation, and location with pump manufacturer.
3. Paint aluminum surfaces that will be in contact with concrete with alkali-resistant bituminous paint.
4. Isolate dissimilar metals from contact using neoprene washers or other suitable means.
5. Submit access frame and cover details and other pertinent data to Engineer under provisions of Section 01 300.
6. Approved Manufacturers:
 - a. Halliday Products
 - b. Approved Equivalent

2.11 COMPONENTS

- A. Strap Anchors: Bent shape, 304 stainless steel, 2 inches wide x 1/4 inch thick x required length.
- B. Pipe Connectors: Cast-in resilient type (Ferncos) with stainless steel straps.

2.12 CONFIGURATION

- A. Valve Vault, Air Release Structures, and Manhole Sections Shaft Construction: Concentric; lipped male/female joints.
- B. Clear Inside Dimensions: As indicated on the Drawings.
- C. Design Depth: As indicated on Drawings.
- D. Clear Lid Opening: 27- inch diameter or as indicated on Drawings.
- E. Adjusting Rings: Provide a maximum of three (3) 2-inch thick, 27-inch diameter adjustment rings between the precast concrete and the casting frame.

- F. Valve Vault, and Manholes: As specified by pump manufacturer or as indicated on the Drawings.
- G. Manhole Steps: Minimum of 10 inches in width, 12 inches on center vertical spacing, set into manhole walls in accordance with ASTM C478.13.
- H. Pipe and Conduit Entry: Provide sleeve openings as required to accommodate annular seal type fittings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify locations, elevations, and sizes of all existing and new pipes entering or leaving manholes and valve manhole before casting sections.
- D. Verify excavation for manholes is correct.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other Sections.

3.3 PLACING MANHOLE SECTIONS

- A. Construct concrete bench, fillet, and channel in accordance with ASTM C478 as shown on the Drawings.
- B. Place precast sections plumb and level, trim to correct elevations, anchor to base pad.
- C. Cut and fit for pipe conduit openings.
- D. Grout base of shaft sections and lifting holes as shown on Drawings. Trowel smooth. Contour as required.
- E. Install preformed plastic sealing compound or water stop, or, if approved by Engineer, concrete and grout, as required between joints of manhole sections, pipe sections, and base sections to assure leak proof manhole, lift station, and valve manhole installations.
- F. Install tie bars where so indicated on the drawings.
- G. Grout lifting holes neatly to the curvature of barrel with masonry cement. Trowel smooth.
- H. Set cover frames and covers level without tipping, to correct elevations.
- I. Coordinate with other sections of work to provide correct size, shape, and location.
- J. Perform installation of protective surface coating on inside of wet wells in accordance with Section 09900.

END OF SECTION

SECTION 33 1116**SITE WATER LINES****PART 1 GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Underground water main pipe, fittings, valves, fire hydrants, bedding, appurtenances, and installation.
 - 2. Water service lead tubing, appurtenances and installation.
 - 3. Water main pressure testing.
 - 4. Temporary water service.
- B. Related Sections include, but are not limited to:
- C. Section 01 3300 – Submittal Procedures.
- D. Section 01 4500 – Quality Control.
- E. Section 01 5200 – Construction Facilities.
- F. Section 01 7800 – Closeout Submittals.
- G. Section 31 2330 - Trenching.
- H. Section 33 1300 - Disinfection of Water System.

1.2 REFERENCES

- A. Reference Standards include:
 - 1. ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Gray-Iron and Ductile-Iron Pipe and Fittings for Water.
 - 2. ANSI/AWWA C110/A21.10 - Gray-Iron and Ductile-Iron Fittings, 3-Inch through 48-Inch, for Water and Other Liquids.
 - 3. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Gray-Iron and Ductile-Iron Pressure Pipe and Fittings.
 - 4. ANSI/AWWA C 115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - 5. ANSI/AWWA C150/A21.50 - American National Standard for Thickness Design of Ductile-Iron Pipe.
 - 6. ANSI/AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
 - 7. ANSI/AWWA C153/A21.53 - Ductile-Iron Compact Fittings, 3-Inch through 12-Inch, for Water and Other Liquids.
 - 8. AWWA C502 - Dry Barrel Fire Hydrants.
 - 9. AWWA C509 - Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewage Systems.
 - 10. AWWA C550 - Standard for Protective Epoxy Interior Coating for Valves and Hydrants.
 - 11. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
 - 12. AWWA C605 - Underground Installation of PVC Pressure Pipe and Fittings.

13. AWWA C800 - Standard for Underground Service Line, Valves, and Fittings.
14. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 in., for Water.
15. AWWA C907 - Polyvinyl Chloride (PVC) Pressure Fittings for Water-4in. through 8 In.
16. AWWA C906 – Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 63 In., for Water Distribution.
17. ASTM B88 - Seamless Copper Water Pipe.
18. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
19. ASTM D1784 - Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds.
20. ASTM D1785 - Poly (Vinyl Chloride) Plastic Pipe, Schedules 40, 80, and 120.
21. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
22. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe fittings, Schedule 80.
23. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
24. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil Aggregate Mixtures in Place by Nuclear Methods (Shallow Depth).
25. ASTM D3139 - Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
26. UL 246 - Hydrants for Fire-Protection Service.
27. NSF Standard No. 14, 60, and 61 - National Sanitation Foundation.
28. WW-T-779c - Federal Specifications.

1.3 SUBMITTALS FOR REVIEW

- A. See Division 01 for submittal procedures.
- B. Product Data: Provide data on materials in accordance with Section 013000 for all piping, fittings, valves, fire hydrants, corporation stops, curb stops, tapping sleeves, service and tapping saddles, transition couplings, pipe adapters, and specialties.
- C. Manufacturer's Instructions: For valves, hydrants, and specialties, furnish in accordance with Section 013300 manufacturer's printed instruction for delivery, handling, storage, assembly, installation, adjustment, special tool requirements, and maintenance requirements.

1.4 SUBMITTALS FOR CLOSEOUT

- A. Section 017800: Procedures for closeout submittals.
- B. Provide all special tools required for valves, hydrants, and specialties.
- C. Provide records of measured depths of water mains, service leads, valves, connections, transition couplings, adapters, thrust blocking; measured horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements; measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work; and field changes of dimension and detail.

1.5 QUALITY ASSURANCE

- A. Valves: Provide manufacturer's name, valve size, and pressure rating marked on valve body.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves and fire hydrants in shipping containers with labeling in place.
- B. Tag each fire hydrant and valve to correspond with the location shown on the Drawings.

PART 2 PRODUCTS**2.1 MATERIALS****A. Water Pipe:**

- 1. Polyvinyl Chloride (PVC) Pipe:
 - a. AWWA C900 Class 150 for sizes 4 inches to 12 inches in diameter.
 - b. All pipe to have standard cast iron pipe outside dimension.
 - c. Ductile Iron Fittings:
 - 1) C900 PVC pipe (4 inches to 12 inches): Grip-Tite, SSB, ductile iron Class 350 fittings conforming to ANSI/AWWA C153/A21.53 compact push-on fittings.
 - 2) PVC fittings maybe used in-lieu of ductile iron fittings for PVC pipe installations 12 inches and smaller. PVC fittings shall meet all applicable requirements of the latest edition of AWWA C900 and AWWA C907.
 - d. Provide restrained joints and fittings where so indicated on the drawings.
 - e. Push-on or mechanical rubber gasket joints conforming to the compression gasket ring requirements of ANSI/AWWA C111/A21.11 and ASTM D3139, and as shown on Drawings.
 - f. Cement line pipe fittings in accordance with ANSI/AWWA C104/A21.4.
 - g. Buried and submerged ductile iron pipe fittings shall have a bituminous exterior coating (asphalt coating).
 - h. Encase buried ductile iron fittings with polyethylene conforming to ANSI/AWWA C105/A21.5.
 - i. Provide stainless steel nuts, bolts, and glands.
 - j. Nuts, bolts, glands, and gaskets incidental.

B. Gate Valves:

- 1. Minimum working pressure of 200 psi for 4-inch to 12-inch valves
- 2. Valve body and rubber-encapsulated wedge constructed of ductile iron or cast iron.
- 3. Resilient seat gate, bubbletight closure design.
- 4. Meet or exceed the ANSI/AWWA C509 standards.
- 5. Bronze stem and stem nut.
- 6. Epoxy-coated interior and exterior.

7. Equipped with non-rising stem with 2-inch square operating nut, open left (counter clockwise) rotation.
8. Provide adjustable valve box riser, cover marked "Water", T-wrench of sufficient length (one wrench for each five valves installed), and polyethylene encasement conforming to ANSI/AWWA C105/A21.5 for buried valves.
9. Mechanical joints for gate valves of all sizes. Provide stainless steel control rods for mechanical joints.
10. Provide gaskets. All underground bolts and nuts to be type 304 stainless steel.
11. Approved manufacturers:
 - a. American Flow Control
 - b. Mueller Company
 - c. Waterous Valve Company
 - d. A.P. Smith Valve Company
 - e. M & H Valve Company
 - f. American-Darling Valve
 - g. Clow Valve Company
 - h. Approved Equivalent

C. Fire Hydrants:

- a. Dry barrel type manufactured in accordance with ANSI/AWWA C502 and UL 246 with breakaway traffic flange such that automatic, positive shut-off of the hydrant is maintained if the hydrant is damaged.
- b. Rated for minimum working pressure of 150 psig.
- c. Equipped with a main valve, which opens against water system pressure. Main valve shall be bronze seated and valve seat shall have a minimum 5-inch diameter opening and thread into a non-clog bronze drain ring.
- d. Removable internal hydrant parts through the hydrant barrel without need for excavation.
- e. Hydrant extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.
- f. Provide two (2) 2-1/2 inch hose nozzle connection and one (1) 4-1/2 inch pumper nozzle connection. Thread pattern shall conform to City standards.
- g. Counter clockwise opening rotation; hydrant operating nut for main hydrant valve.
- h. All underground bolts to be type 304 stainless steel.

- i. Minimum bury depth shall be 7½ feet.
- j. Connect hydrants to hydrant lead piping; provide mechanical restraint and adapters as required.
- k. Gate valve on hydrant lead is specified separately in this section.
- l. Provide hydrant operating wrench for each hydrant.
- m. Finish: Primer and two coats of enamel of color required by Owner. Repair finish damaged in shipping or handling.
- n. Approved manufacturers:
 - 1) Pacer WB67-250 with extended head and 22 inch breakoff by Waterous Company

D. Service and Tapping Saddles:

- 1. All stainless steel tapped outlet, band clamps, nuts, bolts, and washers.
- 2. Heavy gauge type 304 stainless steel shell construction, passivated welds, double bolt type with minimum band width of 6 inches, and rubber "O"-ring gasket pad meeting ASTM D2000.
- 3. Meet or exceed the ANSI/AWWA C800 standards, 200 psig.
- 4. Approved manufacturers:
 - a. Romac Industries, Inc.
 - b. Dresser Industries
 - c. The Ford Meter Box Company
 - d. Or approved equal

E. Tapping Sleeve:

- 1. Stainless steel full wrap around body.
- 2. All stainless steel tapped outlet, nuts, bolts, washers.
- 3. Gasket to provide seal around full circumference of pipe.
- 4. Approved manufacturers:
 - a. Romac Industries, Inc.
 - b. The Ford Meter Box Company
 - c. Or approved equal

F. Reaction Backing (Thrust Blocks):

- 1. Conform to details shown on Drawings for bends, tees, fire hydrants, dead end plug, and service tap connections.
- 2. 3,000 psi concrete for pipe, fittings, and plugs unless specifically shown otherwise on Drawings.

3. Pre-mix concrete sack for service tap connections as shown on Drawings.
- G. Bedding and Backfilling:
 1. Schedule: As specified in Section 312330 and detailed on Drawings.
 2. Materials: As specified in Section 312330.
- H. All products coming into contact with water intended for use in a public water system shall meet ANSI/NSF Standards 60 and 61. A product will be considered as meeting this standard if so certified by NSF, UL, or other organizations accredited by ANSI to test and certify such products.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert elevations are as indicated.

3.2 PREPARATION AND STORAGE

- A. Store pipe on-site on flat surface so barrel is evenly supported. Do not stack higher than six (6) feet. Cover pipe with opaque material for extended storage. Keep ends of stored pipe covered until installation.
- B. Remove scale and dirt on inside and outside of pipe, fittings, valves, and appurtenances before assembly. Inspect pipe and other materials for damage before installation.

3.3 REMOVAL OF EXISTING WATER MAIN PIPE AND APPURTENANCES

- A. Excavate trench per Section 312330.
- B. Remove water main pipe, fittings, valves, hydrants, service leads, concrete vaults, abandoned utilities, other associated appurtenances, and debris shown on Drawings or encountered along the route of the new water main in a manner and schedule that minimizes disruption of water distribution service and traffic.
- C. Dispose of, or at Contractor's option salvage, all other distribution system and service connection materials off-site and in accordance with all applicable laws and regulations.
- D. Notify Engineer and Owner at least seven (7) days in advance of temporary disruptions of water service at locations along route of construction. Coordinate the scheduling of service disruptions and connection operations with the Owner so as to least interfere with existing water system service.

3.4 BEDDING

- A. Excavate pipe trench in accordance with Section 312330 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

- B. Form and place concrete for pipe thrust restraints at any change of pipe direction, tee, plug, or hydrant. Place 3,000 psi concrete to permit full access to pipe and pipe accessories. Comply with details on Drawings for bends, tees, fire hydrants, and service tap connections.
- C. Place PVC Pipe Bedding material per Section 312330 and the details on the Drawings.
- D. Place backfill per Section 312330 and the details on the Drawings.

3.5 INSTALLATION - PIPE, VALVES, HYDRANTS, AND APPURTENANCES

- A. Install all pipe and appurtenances in strict accordance with manufacturer's recommendations and in accordance with AWWA 600 and AWWA C605, as applicable.
- B. Install water main, service leads, and appurtenances so as to avoid existing utilities. Maintain separation from sewer pipes as specified in SEWER CROSSING REQUIREMENTS of this Section.
- C. All foreign material or dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench and it shall be kept clean by approved means during and after laying.
- D. Cut pipe in a neat and workmanlike manner without damaging the pipe.
- E. Trench preparation shall proceed in advance of pipe installation only so far as can be backfilled the same day, or as permitted by the purchaser's specifications.
- F. Contractor may, in suitable locations, install pipe by trenchless methods for convenience. If trenchless method requires substitution of pipe material, new pipe material shall meet equivalent pressure class and inside diameter of new pipe material shall be equal to or greater than specified PVC material. Damage to existing utilities resulting from trenchless installation methods shall be Contractor's responsibility to repair damaged utility.
- G. Excavate and backfill excavations, bore pits, and trenches in accordance with Section 312330. All trenches, excavations, and boring pits shall be sheathed and braced, as necessary, so as to provide a safe place for workmen. Comply with all applicable OSHA safety requirements relating to trenching, boring operations, confined spaces, and other aspects of this type of construction.
- H. Keep trenches free from surface and ground water until pipe jointing is complete.
- I. Locate curb stop valves, gate valves, and hydrants a uniform distance from property line, utility easement line, back of curb, or other applicable line, when so required by municipal code or policy or so directed by Engineer.
- J. All hydrants, valves, and fittings shall be set on cast in place or precast concrete blocks in order to prevent the weight from being transmitted to the pipe.
- K. Form and place concrete for thrust blocking at each bend, tee, change of direction, plug, or hydrant. Thrust blocks shall bear on undisturbed trench wall.

- L. When pipe laying is not in progress, the open end(s) of the pipe and fittings shall be plugged. The temporary plug shall be the same size and type used to make a permanent closure to insure a watertight plug and absolute cleanliness inside the pipe.
- M. Install valve boxes plumb and directly over valve.
- N. Adjust gate valve and curb stop boxes as shown on Drawings. Set boxes to allow equal movement both above and below finish grade. When in street, set valve boxes $\frac{1}{2}$ inch below finish street grade. See Drawings for curb stop valve details at grade.
- O. Reconnect downstream end of the curb stop and gate valves to existing services with appropriate connectors and couplers. Comply with connections and couplings shown on Drawings unless otherwise approved by Engineer.
- P. Hydrant Installation:
 - 1. Clean hydrant interiors before installation.
 - 2. Tighten stuffing boxes and inspect hydrants in opened and closed positions to insure all parts are in working condition.
 - 3. Locate top nut elevation of hydrant as shown on the Drawings. Contractor can either provide hydrants meeting the required elevations or provide hydrants with hydrant extensions (incidental to the hydrant) such that the required elevations are met. If extensions are used, Contractor shall be required to install them as directed by the City Water Department.
 - 4. All hydrants shall stand plumb and have their nozzles parallel with or at right angles to the curb with the pumper nozzle pointing normal to the curb. Traffic flange bolts shall be above the final grade. The traffic flange shall be no more than 6 inches above the final grade.
 - 5. Pour thrust block from back of fire hydrants to undisturbed trench wall. Use bridle rods and rod collars of not less than $\frac{3}{4}$ inch stock protected by a coat of acid-resistant paint when, in the opinion of the Engineer, the character of the soil is such that the hydrant cannot be securely wedged.
 - 6. Place not less than 7 cubic feet of Class 2 aggregate around the base of new hydrants to insure drainage.
- Q. Pipe and Service Lead Installation:
 - 1. Contractor shall acquire a water tapping permit for tapping any existing water main. The fee for the permit shall be paid by the Contractor. Contractor may choose to hire the City Water Department to make the tap.
 - 2. Install water main and water service leads at a minimum depth of cover of 8 feet. Construct to lines, grades, and dimensions shown on Drawings.
 - 3. Take up and relay any pipe disturbed from its required grade or alignment.
 - 4. Install pipe to allow for expansion and contraction without stressing pipe.
 - 5. Install pipe such that maximum deflections from straight line or grade do not exceed manufacturer's specifications. Install bend fittings where maximum deflections are exceeded.
 - 6. Locate water service leads and curb stops with the property owner when such locations are not shown on the Drawings.

- 7. Install access fittings to permit disinfection of water system performed under Section 33 1300.
- 8. Connect new water supply and/or distribution mains to existing water supply and/or distribution mains wherever necessary. Provide adequate adapters and couplers for connections of different pipe types and sizes.
- R. Encase all metallic pipe, fittings, valves, fire hydrants, service saddles, couplings, connectors, and other appurtenances in polyethylene sheeting or tubing in accordance with AWWA C105.
- S. Inspection: Do not cover pipe, fittings, valves, couplings, or hydrant barrels until all bedding, joints, and polyethylene wrap have been inspected.
- T. Contractor shall be responsible for cleaning and restoring to full operation of property owner's internal operation (i.e. flow meter, backflow preventer, fire protection, sprinkler line, etc.) if as a result of connecting to existing service lead internal operation is adversely affected.
- U. Replace any pipe, fittings, or appurtenances found defective after installation has been completed.
- V. Water main shall be installed as designated on drawings. Methods of installation include cased bore, non-cased bore and push, and open cut.

3.6 DISINFECTION OF WATER SYSTEM

- A. Flush and disinfect system in accordance with Section 33 1300.

3.7 FIELD QUALITY CONTROL

- A. Section 014500 - Quality Control: Field inspection and testing.

3.8 HYDROSTATIC TESTING

- A. Subject newly laid pipe to a leakage and hydrostatic pressure test at 150 psi test pressure for a period of two hours. Provide test pump, pipe taps, connecting piping, test gauge and all necessary appurtenances.
- B. Fill water main with water a minimum of 24 hours before the test and expel all air from the main.
- C. Avoid development of water hammer in pipeline.
- D. Add make-up water from a vessel of known volume whenever gauge pressure at the testing point falls 5 psi below the required test pressure or on a continuous basis if a suitable by-pass test pump is used, when performing the test.
- E. Add make-up water shall through a corporation stop; not through fire hydrant.
- F. Pressure test service leads and laterals with water mains prior to connection to user services.
- G. Test against closed valves block to block.
- H. Leakage shall not exceed the allowances indicated below:

	ALLOWABLE LEAKAGE IN U.S. GALLONS PER HOUR FOR
--	---

NOMINAL PIPE SIZE (INCHES)	1000
	LINEAL FEET
	AVERAGE TEST PRESSURE IN LINE: 150 PSI
1	0.09
1.5	0.14
2	0.18
3	0.28
4	0.37
6	0.55
8	0.74
10	0.92
12	1.10

**3.1 IF PIPELINE TEST SECTION INCLUDES VARIOUS DIAMETERS, THEN
ALLOWABLE LEAKAGE SHALL BE THE SUM**

- A. of the computed leakage for the applicable lengths of each size.
- B. Locate and repair any visible leaks and any defective areas if test fails.
- C. Retest after completion of repairs.
- D. Repeat procedure until tests pass.

3.2 SEWER CROSSING REQUIREMENTS

- A. Install water mains no closer than a horizontal distance of 10 feet from sewer lines, except: when crown of sewer is at least 18 inches below invert of the water main and the sewer is laid in a separate trench or water main is laid to one side of common trench on a bench of undisturbed soil, separation shall be 6 feet horizontally.
- B. Install water main no closer than a vertical distance of 18 inches between the invert of top pipe and crown of bottom pipe at crossings.
- C. Where new water main crosses an existing sewer:
 - 1. Center a full standard pipe length of water main over (or under) sewer if crossing is within 3 feet above sewer or below sewer.
 - 2. No additional protection required if water main is at least 3 feet above sewer.
- D. Provide thoroughly compacted backfill between pipes where a new pipe crosses a new or existing pipe for adequate support.

3.3 DATA

- A. In accordance with Section 017800, provide records of measured depths of water mains, service leads, valves, fittings, connections, transition couplings, adapters, thrust blocking; measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements; measured locations of internal utilities and appurtenances

concealed in construction, referenced to visible and accessible features of the Work; and field changes of dimension and detail.

3.4 TEMPORARY WATER SERVICE

- A. Notify Engineer and Owner at least seven (7) days in advance of the time that service disruptions and connections are scheduled. Notify all users 24 hours prior to interruption of service. Coordinate the scheduling of service disruptions and connection operations with the Owner so as to least interfere with existing water service system.
- B. Provide a licensed master plumber, who will be responsible for the proper installation of the temporary water service system and is in charge of such work per the requirements of the North Dakota State Plumbing Board.
- C. Provide all materials, hoses, and labor for installation of temporary water service connections where temporary service disruptions are required during construction and where service will be interrupted for more than two (2) hours.
- D. Disinfect and flush temporary water materials and hoses prior to the installation of the temporary water service system.
- E. Provide backflow preventive devices on temporary water supply.
- F. Maintain the following 40 psi flow rates for service connections:
 - 1. 1 gallon per minute for 1-inch or smaller services.
 - 2. 4 gallons per minute for 2-inch services.
 - 3. 100 gallons per minute for 4-inch services.
 - 4. 150 gallons per minute for 6-inch services.
 - 5. 200 gallons per minute for 8-inch services.
- G. Place temporary piping in locations that do not interfere with traffic.
- H. Clearly mark temporary piping with flags, cones, barricades, etc. to prevent injury to pedestrians.

END OF SECTION

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SECTION 33 1300

DISINFECTION OF WATER SYSTEM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disinfection of water system.
- B. Testing and reporting results.

1.2 RELATED SECTIONS

- A. Section 01 3300 – Submittal Procedures.
- B. Section 01 4500 – Quality Control.
- C. Section 01 7800 – Closeout Submittals.
- D. Section 33 1116 - Site Water Lines.

1.3 REFERENCES

- A. AWWA B300 - Standard for Hypochlorites.
- B. AWWA B301 - Standard for Liquid Chlorine.
- C. AWWA C651 - Standards for Disinfecting Water Mains.
- D. Federal Specifications BB-C-12a, O-C-114a, and O-S-602b.

1.4 DEFINITIONS

- A. Disinfectant Residual means the quantity of disinfectant in treated water.
- B. PPM means parts per million.

1.5 SUBMITTALS FOR INFORMATION

- A. See Division 01 for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.

1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 013300 and Section 017800.
- B. Disinfection report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfectant injection start and time of completion.
 - 3. Test locations.
 - 4. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - 5. Date and time of flushing start and completion.
 - 6. Disinfectant residual after flushing in ppm for each outlet tested.
- C. Bacteriological report:
 - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
 - 2. Time and date of water sample collection.

3. Name of person collecting samples.
4. Test locations.
5. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
6. Coliform bacteria test results for each outlet tested.

1.7 QUALITY ASSURANCE

- A. Regulatory Agency Requirements: Comply with North Dakota Department of Health requirements.
- B. Testing Firm: Company specializing in testing potable water systems, approved by the North Dakota Department of Health.
- C. Submit bacteriologist's signature and authority associated with testing.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect against damage and contamination.
- B. Maintain caution labels on hazardous materials.
- C. Maintain storage room dry and with temperatures as uniform as possible between 60 and 80° F.
- D. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

- A. AWWA B300, Hypochlorite: Shall conform to Federal Specification O-C-114a, Type II, Grade B, or Federal Specification O-C-602b.
- B. AWWA B301, Liquid Chlorine: Shall conform to Federal Specification BB-C-120a.

PART 3 EXECUTION

3.1 DISINFECTION OF WATER SYSTEMS

- A. Verify that piping system has been cleaned, inspected, and pressure tested.
- B. Perform disinfecting in accordance with AWWA C651 prior to start-up. Coordinate with other Contractors, Engineer, and Owner.
- C. Provide and attach required equipment to perform the work of this Section. Disinfectant material shall be introduced into the water system in a manner approved by the Engineer.
- D. Inject treatment disinfectant into piping system to obtain 50 to 80 ppm residual.
- E. Maintain disinfectant in system for 24 hours. If disinfectant residual is less than 25 ppm, repeat system treatment.
- F. Flush, circulate, and clean until required cleanliness is achieved; use system water supply.
- G. Dispose of heavily chlorinated water properly.

3.2 FIELD QUALITY CONTROL

- A. Section 01 4500 - Quality Control: Field inspection and testing.
- B. Two or more successive test samples indicating bacteriological satisfactory water shall be obtained before facility is placed into operation.
- C. All testing costs shall be paid by Contractor.

END OF SECTION

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SECTION 33 3111**SANITARY SEWAGE SYSTEM****PART 1 GENERAL****1.1 SUMMARY****A. Section includes:**

1. Sanitary sewer collection piping, fittings, accessories, and bedding.
2. Sewer service piping, fittings, and appurtenances.

B. Related Section include:

1. Section 01 3300 – Submittal Procedures.
2. Section 01 4500 – Quality Control.
3. Section 01 7700 – Closeout Procedures.
4. Section 01 7800 – Closeout Submittals.
5. Section 31 2324 - Soil Materials.
6. Section 31 2326 - Aggregate Materials.
7. Section 31 2323 - Backfilling.
8. Section 31 2330 - Trenching.
9. Section 33 0513 - Precast Concrete Pipe Structures, Manholes, and Covers.

1.2 REFERENCES**A. Reference Standards include:**

1. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch Drop.
2. ASTM D2321 - Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
3. ASTM D2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3034 - Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings.

1.3 DEFINITIONS

- A. Bedding:** Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 SUBMITTALS FOR REVIEW

- A.** See Division 01 for submittal procedures.
- B.** Section 01 3300 – Submittal Procedures: Procedures for submittals.
- C.** Product Data: Provide data indicating pipe, fittings, joints, and pipe accessories.

1.5 SUBMITTALS FOR INFORMATION

- A.** Section 01 3300 – Submittal Procedures: Procedures for submittals.

- B. Manufacturer's Instructions: Indicate special procedures required to install Products specified.
- C. Certificates: Certify that products meet or exceed specified requirements.

1.6 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Section 01 7700 – Closeout Submittals: Procedures for submittals.
- B. Record location of pipe runs, connections, inverts elevations, and control points.
- C. Identify, indicate, and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

- A. Plastic Pipe: ASTM D3034, SDR 35, Type PSM, Poly Vinyl Chloride (PVC) material, with rubber gasket joints.
- B. Fittings: Same material as pipe, wyes, tees, bends, elbows, ends to suit pipe joints.

2.2 PIPE ACCESSORIES

- A. Pipe Joints and Fittings: Push-on bell and spigot gasketed joints.
- B. Transition Couplings: Rubber sewer repair coupling with stainless steel bands, as manufactured by Fernco, or approved equal.

2.3 BEDDING MATERIALS

- A. Aggregate Bedding: Special Class I PVC bedding material as specified in Section 312326.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION AND STORAGE

- A. Hand trim excavations to required elevations. Correct over excavation with Type A1 aggregate.
- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.
- C. Store pipe on-site on flat surface so barrel is evenly supported. Stack no higher than 4 feet.
- D. Inspect for damage to pipe and other materials.
- E. Store materials in a manner acceptable to Engineer.

3.3 BEDDING

- A. Excavate for pipe installation as required with Section 31 2316 and 31 2330 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.

- B. Place bedding material at trench bottom in accordance with Section 31 2323 and 31 2330, level materials in continuous layers not exceeding 6 inches compacted depth, compact to 95 percent of ASTM D698 maximum density. Bedding material shall be Special Class I PVC pipe bedding material in compliance with City of Grand Forks Standard Specifications.
- C. Maintain moisture content of bedding material at optimum to plus or minus 2 percent to attain required compaction density.

3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321 or with manufacturer's instructions when appropriate. Seal joints watertight.
- B. Lay pipe true to line shown on Drawings and true to slope gradients noted on Drawings, with maximum variation from true slope of 1:1000.
- C. Install bedding at sides of pipe to minimum compacted thickness shown on Drawings; compacted to 95 percent of ASTM D698 maximum density.
- D. Refer to Sections 31 2316, 31 2323, and 31 2330 for excavation, trenching, and backfilling requirements. Do not displace or damage pipe when compacting.
- E. Keep excavation area free from water until pipe jointing is completed. Securely close open ends of pipe and fittings when work is not in progress.
- F. Refer to Section 33 0513 for manhole requirements.

3.5 FIELD QUALITY CONTROL

- A. Section 01 4500 - Quality Control: Field inspection and testing.
- B. Request inspection prior to placing backfill above pipe.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- D. Frequency of Compaction Tests: In accordance with Section 31 2200.
- E. Leakage Test: Test in accordance with Section 33.94 or 33.95 of the 1997 Recommended Standards for Wastewater Facilities, Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (Ten States Standards).
- F. Deflection Test: Test in accordance with Ten States Standards, Section 33.85.

3.6 PROTECTION OF FINISHED WORK

- A. Section 01 7700 – Closeout Procedures: Protecting installed work.
- B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

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SECTION 33 4100**STORM SEWER SYSTEM****PART 1 GENERAL****1.1 SUMMARY****A. Section Includes**

1. Storm inlets and manholes.
2. Storm sewer pipe.
3. Related items necessary to provide a complete installation.

B. Related sections included, but are not limited to:

1. Section 01 3000 – Administrative Requirements.
2. Section 01 4500 – Quality Control.
3. Section 01 7700 – Closeout Procedures.
4. Section 01 7800 – Closeout Submittals.
5. Section 31 2324 – Soil Materials.
6. Section 31 2326 – Aggregate Materials.
7. Section 31 2323 – Backfilling.
8. Section 31 2330 – Trenching.
9. Section 33 0513 – Precast Concrete Pipe Structures, Manholes, and Covers

1.2 REFERENCES**A. Reference sections include, but are not limited to:**

1. ASTM A48 – Standard Specification for Gray Iron Castings
2. ASTM C478 – Precast Reinforced Concrete Manhole Sections.
3. ASTM D698 – Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using a 5.5 lb. (2.49 kg) Rammer and a 12-inch (304.8 mm) Drop.
4. ASTM D3034 – Type PSM, Polyvinyl Chloride (PVC).
5. ASTM 3786 – Mullen Burst.
6. ASTM D4632 – Grab Tensile Strength and Elongation.

1.3 SUBMITTALS FOR REVIEW

- A.** See Division 01 for submittal procedures.
- B.** Shop Drawings: Indicate locations, elevations, piping, dimensions, and elevations of storm service connections.
- C.** Product Data: Provide data indicating pipe and pipe accessories.

1.4 SUBMITTALS FOR INFORMATION

- A.** Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- B.** Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Accurately record actual locations of pipe runs, connections, catch basins, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.7 REGULATOR

- A. Conform to applicable code for materials and installation of the Work of this section.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature at 50 degrees F (10 degrees C) minimum prior to, during, and 48 hours after installation of masonry Work.

PART 2 PRODUCTS**2.1 USE OF PIPE MATERIALS**

- A. Where indicated on the Drawings as "RCP," Reinforced Concrete Pipe shall be used.

2.2 REINFORCED CONCRETE PIPE MATERIALS

- A. Reinforced concrete pipe shall conform to ASTM designation C76, Class III, Wall B. Joints shall be rubber gasket type conforming to ASTM C443. Allowable pipe lengths shall not exceed eight (8) feet and each section of pipe shall be clearly marked with the following information:
 - 1. The pipe class.
 - 2. The date of manufacture.
 - 3. The name or trademark of the manufacturer.

2.3 DRAIN TILE

- A. Drain tile for storm sewer shall be PVC underdrain pipe with woven sock. Pipe shall meet ASTM D-3034-PS46 specifications and shall have gasketed joints. Pipe shall have 4 rows of ¼" diameter perforations spaced at 3" apart. Sock for drain tile shall be geotextile fabric Type D3 or D4 as specified in Section 858 of the North Dakota Department of Transportation Standard Specifications.

2.4 DRAINAGE FABRIC

- A. NDDOT Geotextile Fabric for Drainage
 - 1. Type D3 and D4 fabric shall only be used as a geotextile fabric sock. The type D4 fabric shall be knit of 150 denier (min) polyester yarn, exhibit minimum snag or "run" potential, be factory-applied to maintain a uniform installed weight, and conform to the outside diameter of the pipe with a snug fit throughout.

2.5 CHIMNEY SEAL & EXTENTIONS

- A. Chimney Seal & Extentions: External type chimney seals, manufactured by Cretex Specialty Products, or approved equal. All fastening devices shall be stainless steel.

2.6 REINFORCED CONCRETE MANHOLES AND INLETS

- A. In conformance with Section 33 0513

2.7 CASTINGS

- A. Castings shall conform to the Drawings.
- B. Each casting shall be furnished with three standard 2-inch adjusting rings, as necessary to accommodate the new elevations and grades required.

2.8 ACCESSORIES

- A. Grout: Non-shrink masonry cement premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi in 48 hours and 7,000 psi in 28 days.
- B. Sewer Repair Couplings: Rubber couplings with stainless steel bands, as manufactured by Fernco, or approved equal.

2.9 BEDDING MATERIALS

- A. Bedding shall be as specified in Section 31 2326.

PART 3 EXECUTION**3.1 EXAMINATION**

- A. Verify that subgrade is graded to proposed elevations and compacted according to Drawings and Specifications.
- B. Verify storm service connection pipe sizes, depths, and locations.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation as specified in Section 31 2200.
- B. Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 31 2316 for Work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding in bottom of trench and compact as specified in Section 31 2323. Maintain appropriate moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with manufacturer's instructions.
- B. Lay pipe to slope gradients noted on Drawings.
- C. Refer to Sections 31 2316, 31 2323, and 31 2330 for excavation, trenching, and backfilling requirements. Do not displace or damage pipe when compacting.

3.5 ADJUSTMENTS OF MANHOLE AND INLET CASTINGS

- A. Adjusting rings should be set in place in configuration shown on the Drawings.
- B. Install chimney seal to manufacturer's specifications to provide support, floating casting movement, and watertight connections.
- C. Completely enclose chimney seal in A4 aggregate.
- D. Set frames and grates level without tipping, to correct elevations.
- E. Drill holes, if required, for #5 Rebar into casting as shown on Drawings.
- F. Coordinate with other sections of Work to provide correct size, shape, and location.

3.6 FIELD QUALITY CONTROL

- A. Compaction testing:
 - 1. Perform in accordance with Section 31 2200.
 - 2. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.
 - 3. Frequency of Tests: as specified in Section 31 2200.

3.7 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION

**SECTION 33 4110
SUBDRAINAGE****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Building Perimeter and Under-Slab Drainage Systems.
- B. Filter aggregate and fabric and bedding.

1.02 RELATED REQUIREMENTS

- A. Site Drawings and Notes: Excavating for subdrainage system piping, backfilling.

1.03 REFERENCE STANDARDS

- A. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- B. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- C. ASTM D4533/D4533M - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
- D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- E. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile.
- F. ASTM D4833/D4833M - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on pipe drainage products, pipe accessories, and fabric.
- C. Shop Drawings: Indicate dimensions, layout of piping, high and low points of pipe inverts, gradient of slope between corners and intersections, and outlets.
- D. Project Record Documents: Record location of pipe runs, connections, cleanouts and principal invert elevations.

PART 2 PRODUCTS**2.01 REGULATORY REQUIREMENTS**

- A. Comply with applicable code for materials and installation of the work of this section.

2.02 PIPE MATERIALS

- A. Polyvinyl Chloride Pipe: ASTM D2729; plain end, 4 inch inside diameter; with required fittings.
- B. Corrugated Plastic Tubing: Flexible type; 4 inch diameter, with required fittings.
- C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.03 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material: Granular fill as indicated in Drawings and Notes.

2.04 ACCESSORIES

- A. Pipe Couplings: Solid plastic.
- B. Geotextile for Filtration: Capable of allowing liquid passage while restricting solids.
 - 1. Type: Nonwoven.
 - 2. Seams: Lap.
 - a. Overlap: 12 inch.
 - b. Strength: 85 percent of grab, minimum, in accordance with ASTM D4632/D4632M.
 - c. Limit seams perpendicular to direction of construction.
 - 3. Grab Strength: 300 lbf, minimum, when tested in accordance with ASTM D4632/D4632M.
 - 4. Permittivity: 0.5 per second, minimum, in accordance with ASTM D4491/D4491M.
 - 5. Apparent Opening Size: No.40, 0.016 inch, maximum, when tested in accordance with ASTM D4751.

6. Trapezoid Tear Strength: 100 lbf, minimum, when tested in accordance with ASTM D4533/D4533M.
7. Puncture Strength: 450 lbf, minimum, when tested in accordance with ASTM D4833/D4833M.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify that excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.

3.02 PREPARATION

- A. Hand trim excavations to required elevations. Correct over-excavation with _____.
- B. Remove large stones or other hard matter that could damage drainage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION

- A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.
- B. Place drainage pipe on compacted impervious fill.
- C. Lay pipe to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Place pipe with perforations facing up. Mechanically join pipe ends.
- E. Install pipe couplings.
- F. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches.
- G. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.
- H. Place aggregate in maximum 6 inch lifts, consolidating each lift.
- I. Refer to site Drawings and Notes for compaction requirements. Do not displace or damage pipe when compacting.
- J. Connect to storm sewer system with unperforated pipe, through installed sleeves.
- K. Coordinate the Work with connection to municipal sewer utility service, and trenching.

3.04 FIELD QUALITY CONTROL

- A. Section 01 4000 - Quality Requirements: Field inspection and testing.
- B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.05 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION