



for

Prattsburgh Central School District
2025 Capital Improvements Project
1 Academy St. Prattsburgh, NY 14873

SED # - Main Building: 57-23-01-04-0-001-034
SED # - Agricultural Building: 57-23-01-04-0-008-012
SED # - Auxiliary Building: 57-23-01-04-0-002-012
SED # - Toilet Room Facility: 57-23-01-04-7-012-001
SED # - Home Dugout: 57-23-01-04-2-005-001

The design of this project conforms to all applicable provisions of the New York State Uniform Fire Prevention and Building Code, the Energy Conservation Construction Code of New York State, and the building standards of the New York State Education Department

12/18/2025
Issued for Bid: 02/09/2026

HUNT 2716-043

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END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

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

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Schedules:
 - 1. Submit plumbing component identification schedule listing equipment, piping, and valves.
 - 2. Detail proposed component identification data in terms of of wording, symbols, letter size, and color coding to be applied to corresponding product.
 - 3. Valve Data Format: Include id-number, location, function, and model number.
- C. Operation and Maintenance, O&M, Manual Data: Record actual locations of tagged valves, and provide laminated valve chart which includes valve tag numbers, location and function in chart form for placement into Operations and Maintenance Manual.

PART 2 PRODUCTS

2.1 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A. Pipe Markers: 3/4 inch diameter and higher.

2.2 NAMEPLATES

- A. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.

- B. Generator Gas Shutoff Valve: 2 inch by 4 inch, engraved yellow anodized aluminum with rounded corners and 1/4 inch text for exterior use. Nameplate to read "GENERATOR GAS SHUTOFF VALVE - DO NOT TURN OFF". Nameplate to be secured with brass chains. Nameplate available from Craftmark Pipe Markers or Equivalent.
- C. Main Gas Shutoff Valve: 2 inch by 4 inch, engraved yellow anodized aluminum with rounded corners and 1/4 inch text for exterior use. Nameplate to read "BUILDING GAS SHUTOFF VALVE - NOT GENERATOR SHUTOFF". Nameplate to be secured with brass chains. Nameplate available from Craftmark Pipe Markers or Equivalent.

2.3 TAGS

- A. Flexible: Vinyl with engraved black letters on light contrasting background color with up to three lines of text. Minimum tag size 1-1/2 inch in diameter.
- B. Valve Tag Chart: Typewritten letter sized list, plastic laminated. Typewritten letter size list to include applied tag function description, valve tag number and location.

2.4 STENCILS (CONCEALED PIPING)

- A. Stencil Paint:
 - 1. Provide materials that are compatible with one another and the substrate indicated under conditions of service and application.
 - 2. Volatile Organic Compound (VOC) Content: Not exceeding 100g/l.
 - 3. Background and Stencil Paint: Semi-gloss enamel, colors complying with ASME A13.1.

2.5 PIPE MARKERS (EXPOSED PIPING)

- 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.
 - 2. Secondary: Color scheme per fluid service.
 - a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.

2.6 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - 1. Plumbing Valves: Green.

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive identification products.
- B. Prepare surfaces for stencil painting, see Section 09 91 23.

3.2 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags in clear view and align with axis of piping
- C. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.
- D. Apply stencil painted identification in compliance with manufacturer's requirements. Identify unit with assigned id-number and area being served using pipe marking rules.
- E. Install plastic pipe markers in accordance with manufacturer's instructions.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- F. Locate ceiling tacks to locate valves above lay-in panel ceilings. Locate in corner of panel closest to equipment.
- G. Identify concealed piping, with stenciled painting. Identify exposed piping with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Identify valves in main and branch piping with tags.

END OF SECTION

SECTION 22 07 19
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 09 91 23 - Interior Painting: Painting insulation jacket.
- C. Section 22 10 05 - Plumbing Piping and Specialties: Placement of hangers and hanger inserts.
- D. Section 22 05 53 - Identification for Plumbing Piping and Equipment.

1.3 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 2019).
- C. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement; 2007 (Reapproved 2019).
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- H. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- I. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- J. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation; 2022.
- K. ASTM C610 - Standard Specification for Molded Expanded Perlite Block and Pipe Thermal Insulation; 2017 (Reapproved 2023).

- L. ASTM D1056 - Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber; 2020.
- M. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- N. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Maintain ambient conditions required by manufacturers of each product.
- C. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER INSULATION

- A. Manufacturers:
 - 1. Armstrong
- 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: 0.1 percent by volume.
- C. Vapor Retarder Jacket: ASTM C1136 Flexible, Low Permeance Vapor Retarders for Thermal Insulation, Type II. Facing: 1 inch galvanized steel hexagonal wire mesh stitched on one face of insulation.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.

2.3 EXPANDED POLYSTYRENE INSULATION

- A. Manufacturers:
1. Armstrong.
 2. Certainteed Company.
 3. Manville Products
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: ASTM C578; rigid closed cell.
1. K Value: 0.23 at 75 degrees F.
 2. Maximum Service Temperature: 165 degrees F.
 3. Maximum Moisture Absorption: 0.2 percent by volume.
 4. Maximum Water Vapor Permeance: 5.0 perm inch.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
1. Armstrong
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

2.5 JACKETING AND ACCESSORIES

- A. PVC Plastic Pipe Jacket.
1. Manufacturers:
 - a. Armstrong.
 - b. Owens Corning.
 - c. Knauf.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Maximum Service Temperature: 450 degrees F.
 - b. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 15 mil.
 - d. Connections: Brush on welding adhesive.
 3. Covering Adhesive Mastic: Compatible with insulation.
 4. Insulation covering cold water systems shall contain integral vapor retarder system for moisture removal and mold prevention.
- B. Aluminum Jacket:
1. Thickness: 0.020 inch sheet.
 2. Finish: Embossed.
 3. Joining: Longitudinal slip joints and 2 inch laps.
 4. Fittings: 0.016 inch thick die-shaped fitting covers with factory-attached protective liner.
 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 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 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.
- J. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.
- K. Pipe Exposed in Mechanical Equipment and Storage Rooms (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- L. Pipe Exposed in Finished Spaces: Finish with PVC jacket and fitting covers.
- M. 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.

- N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.
- O. Provide insulation to storm piping in its entirety from roof drain, entire length of horizontal storm piping run to main vertical drop.

3.3 SCHEDULES

A. Plumbing Systems:

1. All sizes of Domestic Cold water, 1/2 inch to 1-1/4 inch Hot Water, 1/2 inch to 1-1/4 inch Hot Water Recirculation and 1/2 inch to 1-1/4 inch Tempered Water Piping:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1 inch.
 - b. Cellular Glass Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1 inch.
 - c. Expanded Polystyrene Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1 inch.
 - d. Cellular Foam Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1 inch.
2. 1-1/2 inch and Larger Domestic Hot Water, Hot Water Recirculation and Tempered Water Piping:
 - a. Glass Fiber Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1-1/2 inch.
 - b. Cellular Glass Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1-1/2 inch.
 - c. Expanded Polystyrene Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1-1/2 inch.
 - d. Cellular Foam Insulation:
 - 1) Pipe Size Range: As Noted.
 - 2) Thickness: 1-1/2 inch.
3. Roof Drain Bodies:
 - a. Fiber Glass Insulation with integral vapor retarder. All pipe sizes, 1 inch thick.
 - b. Elastomeric Cellular Foam Insulation. All pipe sizes, 1 inch thick.
 - c. Cellular Glass Insulation. All pipe sizes, 1 inch thick.
4. Exposed Roof Drainage Above Grade
 - a. Fiber Glass Insulation with integral vapor retarder. All pipe sizes, 1 inch thick.
 - b. Elastomeric Cellular Foam Insulation. All pipe sizes, 1 inch thick.
 - c. Cellular Glass Insulation with full PVC jacket. All pipe sizes, 1 inch thick.
5. Concealed Roof Drainage
 - a. Fiber Glass Insulation with integral vapor retarder. All pipe sizes, 1 inch thick.
 - b. Elastomeric Cellular Foam Insulation. All pipe sizes, 1 inch thick.
 - c. Cellular Glass Insulation. All pipe sizes, 1 inch thick.
6. Roof Drainage Run Horizontal at Roof Level:
 - a. Fiber Glass Insulation with integral vapor retarder. All pipe sizes, 1 inch thick.
 - b. Elastomeric Cellular Foam Insulation. All pipe sizes, 1 inch thick.
 - c. Cellular Glass Insulation. All pipe sizes, 1 inch thick.
7. Plumbing Vents Within 10 Feet of the Exterior:
 - a. Fiber Glass Insulation with integral vapor retarder. All pipe sizes, 1 inch thick.
 - b. Elastomeric Cellular Foam Insulation all pipe sizes, 1 inch thick.
 - c. Cellular Glass Insulation. All pipe sizes, 1 inch thick.

- B. Plumbing Systems:
 - 1. Domestic Hot Water Storage Tanks:
 - a. Cellular Glass Insulation: 2 inches thick.
 - 2. Domestic Cold Water Storage Tanks:
 - a. Cellular Glass Insulation: 2 inches thick.
 - 3. Piping Exposed to Freezing with Heat Tracing: All pipe sizes, 1 inch thick.

END OF SECTION

SECTION 22 10 05
PLUMBING PIPING AND SPECIALTIES

PART 1 GENERAL

1.1 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.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- C. Section 22 07 19 - Plumbing Piping Insulation.
- D. Section 31 23 16 - Excavation.
- E. Section 31 23 23 - Fill.

1.3 REFERENCE STANDARDS

- A. ANSI Z21.22 - American National Standard for Relief Valves for Hot Water Supply Systems; 2015 (Reaffirmed 2020).
- B. ANSI Z223.1 - National Fuel Gas Code; 2024.
- C. ASME A112.6.4 - Roof, Deck, and Balcony Drains; 2022.
- D. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- G. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV; 2021.
- H. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2024.
- I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV; 2022.
- J. ASME B31.9 - Building Services Piping; 2020.
- K. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; 2023, with Errata (2024).
- L. 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).
- M. ASSE 1003 - Water Pressure Reducing Valves for Potable Water Distribution Systems; 2023.

- N. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2022.
- O. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.
- P. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2023a.
- Q. ASTM B32 - Standard Specification for Solder Metal; 2020.
- R. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes; 2020.
- S. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed; 2019.
- T. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2020.
- U. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- V. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- W. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV); 2020.
- X. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube; 2016.
- Y. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings; 2023.
- Z. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings; 2020a.
- AA. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter; 2022.
- BB. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020.
- CC. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe; 2021.
- DD. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2020.
- EE. 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.
- FF. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2023.
- GG. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe; 2014 (Reapproved 2021).
- HH. ASTM F679 - Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings; 2021.
- II. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; 2018.
- JJ. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings; 2023.
- KK. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast; 2023.
- LL. AWWA C550 - Protective Interior Coatings for Valves and Hydrants; 2024.
- MM. AWWA C651 - Disinfecting Water Mains; 2023.

- NN. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service; 2020.
- OO. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications; 2021.
- PP. 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.
- QQ. ICC (IFGC) - International Fuel Gas Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- RR. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- SS. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).
- TT. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- UU. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- VV. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).
- WW. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends; 2018.
- XX. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends; 2011.
- YY. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves; 2019.
- ZZ. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends; 2011.
- AAA. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends; 2010, with Errata .
- BBB. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- CCC. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, hangers, supports and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Project Record Documents: Record actual locations of valves.
- D. Hangers and Supports: Submit manufacturers catalog information including load capacity.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.5 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Perform Work in accordance with standards of the State of New York.
- C. Valves: Manufacturer's name and pressure rating marked on valve body.

- D. Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- E. Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- F. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable code for installation of backflow prevention devices.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 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.

2.2 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET OF BUILDING

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

2.3 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. Copper Tube: ASTM B306, DWV, Type L.
 - 1. Fittings: ASME B16.29, wrought copper, or ASME B16.23, solvent.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
- C. PVC Pipe - (Not For Use in Return Air Plenums or Exposed in Places of Assembly.): ASTM D2665.
 - 1. Fittings: PVC.

2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.4 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Pipe: ASTM B42, hard drawn, 2-1/2 inches and smaller.
 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 2. Joints: ASTM B32, alloy Sn95 solder.
- B. Ductile Iron Pipe: AWWA C151/A21.51, 3 inches and larger.
 1. Fittings: AWWA C110, ductile iron, standard thickness. Cement Mortar lining in conformance with AWWA C-104.
 2. Joints: AWWA C111/A21.11, styrene butadiene rubber (SBR) or vulcanized SBR gasket with 3/4 inch diameter rods.
 3. Jackets: AWWA C105/A21.5 polyethylene jacket.
- C. PEX Pipe: Polyethylene cross-linked for Potable water (non-oxygen barrier). Color coded: Blue for cold domestic water and Red for hot domestic water. Complies with ASTM F876, F877, F1807, F2159, 2023, CSA B137.5.
 1. Fittings: PEX designed for use with Potable water piping.

2.5 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tubing for pipe 2 1/2 inches and smaller: ASTM B 88 (ASTM B 88M), Type L (B), Drawn (H)
 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 2. Joints: ASTM B 32, alloy Sn95 solder. Lead free.
- B. Copper Tubing for pipe 3 inches and larger: ASTM B88, Type L (B), hard drawn, rolled grooved ends
 1. Fittings: ASTM B584 bronze sand castings, grooved ends.
 2. Joints: Grooved mechanical couplings meeting ASTM F1476.
 - a. Housing Clamps: ASTM A395/A395M and ASTM A536 ductile iron, enamel coated, compatible with copper tubing sizes, to engage and lock designed to permit some angular deflection, contraction, and expansion.
 - b. Gasket: Elastomer composition for operating temperature range from -30 degrees F to 180 degrees F.
 - c. Accessories: Stainless steel bolts, nuts, and washers.
 3. Mechanically pressed fitting are allowed for this application.

2.6 STORM DRAINAGE PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 service weight, bell and spigot ends.
 1. Fittings: Cast iron, ASTM A74.
 2. Joint Seals: ASTM C 564 neoprene gaskets.
- B. PVC Pipe: ASTM D2665 or ASTM D3034, polyvinyl chloride (PVC) material.
 1. Fittings: PVC, ASTM D2665 or ASTM D3034.
 2. Joints: Solvent welded, with ASTM D2564 solvent cement.
- C. PVC Pipe: ASTM D2665, ASTM D3034, or ASTM F679, polyvinyl chloride (PVC) material.
 1. Fittings: PVC, ASTM D2665, ASTM D3034, or ASTM F679.
 2. Joints: Push-on, using ASTM F477 elastomeric gaskets.

2.7 STORM DRAINAGE PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
 1. Fittings: Cast iron, CISPI 301.
 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.
- B. PVC Pipe (Not For Use in Return Air Plenums or Exposed in Places of Assembly.): ASTM D2665 or ASTM D3034.

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

2.8 ROOF DRAINS

- A. Retrofit Roof Drain:
1. Assembly: ASME A112.6.4.
 2. Body: #16 gage Type 304 stainless steel.
 3. Strainer: Removable aluminum dome.
 4. Accessories: Coordinate with roofing type:
 - a. Membrane flange and membrane clamp with integral gravel stop.
 - b. Roof sump receiver.
 - c. Waterproofing flange.
 - d. Controlled flow weir.
 - e. Leveling frame.
 - f. Perforated or slotted ballast guard extension for inverted roof.
 - g. Perforated stainless steel ballast guard extension.
 - h. Dura-Coated cast iron clamp collar.
 - i. Stainless steel hardware.
 - j. Neoprene gasket.

2.9 PIPE FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 2 inches and Under:
1. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
 2. PVC Piping: PVC
 3. CPVC Piping: PVC
- B. Flanges for Pipe Size Over 2 inches:
1. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
 2. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
 3. PVC Piping: PVC.
 4. CPVC Piping: PVC.
 5. Gaskets: 1/16 inch thick preformed neoprene gaskets.

2.10 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. Conform to ASME B31.9.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
 6. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
 7. Vertical Support: Steel riser clamp.
 8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping - Water:

1. Conform to ASME B31.9.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
 3. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
 4. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.
 5. Hangers for Hot Pipe Sizes 6 inch and Larger: Adjustable steel yoke, cast iron pipe roll, double hanger.
 6. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
 8. Wall Support for Pipe Sizes Up to 3 inch: Cast iron hook.
 9. Wall Support for Pipe Sizes 4 inch and Larger: Welded steel bracket and wrought steel clamp.
 10. Wall Support for Hot Pipe Sizes 6 inch and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe 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 inch: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
 14. Floor Support for Hot Pipe Sizes 6 inch and Larger: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
 15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- 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.
- E. INSERTS
1. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.
- F. FLASHING
1. Metal Flashing: 26 gage thick galvanized steel.
 2. Metal Counterflashing: 22 gage thick galvanized steel.
 3. Lead Flashing:
 - a. Waterproofing: 5 lb./sq. ft sheet lead.
 - b. Soundproofing: 1 lb./sq. ft sheet lead.
 4. Flexible Flashing: 47 mil thick sheet compatible with roofing.
 5. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.
- G. SLEEVES
1. Sleeves for Pipes through Non-fire Rated Floors: 18 gage thick galvanized steel.
 2. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
 3. Sealant: See Section 07 92 00 - Joint Sealants.
- H. MECHANICAL SLEEVE SEALS
1. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.
- I. FORMED STEEL CHANNEL
1. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.
- J. FIRESTOPPING

1. See Section 07 84 00 - Firestopping for firestopping requirements.

2.11 PIPE SLEEVE-SEAL SYSTEMS

- A. Modular Mechanical Seals:
 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 to service requirements.
 4. Glass reinforced plastic pressure end plates.

2.12 BALL VALVES

- A. Manufacturers:
 1. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder or threaded ends with union. Lead free.

2.13 PLUG VALVES

- A. Construction 2-1/2 Inches and Larger: MSS SP-78, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.14 HORIZONTAL SWING CHECK VALVES

- A. Up to 2 Inches:
 1. MSS SP-80, 150, bronze body and cap, bronze swing disc with rubber seat, solder or threaded ends. Lead free.

2.15 SPRING LOADED CHECK VALVES

- A. Up to 2 inches:
 1. MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, threaded ends. Lead free.
- B. 2-1/2 inches and Larger:
- C. MSS SP 71, Class 125, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

2.16 PRESSURE REDUCING VALVES

- A. 2 inch and Smaller:
 1. MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends. Lead free.
 2. Pressure Reducing Pilot-Operator:
 - a. Operating Range: 5 to 50 psi.
 - b. Connected into brass or bronze pilot piping and fittings.
 - c. Fixed flow restrictor, pressure gauges, and isolation valves.
 3. Provide pressure gauge onto inlet side and outlet side piping of valve.
- B. 2 inch and Larger:
 1. ASSE 1003, cast iron body with interior lining complying with AWWA C550, bronze fitted, elastomeric diaphragm and seat disc, flanged.
 2. Pressure Reducing Pilot-Operator:
 - a. Operating Range: 5 to 50 psi.

- b. Connected into brass or bronze pilot piping and fittings.
- c. Fixed flow restrictor, strainer, pressure gauges, and isolation valves.
- 3. Provide pressure gauge onto inlet side and outlet side piping of valve.

2.17 PRESSURE GAUGES

- A. Gauge: ASME B40.1, UL 393 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - 1. Case: Steel
 - 2. Bourdon Tube: Type 316 stainless steel.
 - 3. Dial Size: 3-1/2 inch diameter.
 - 4. Mid-Scale Accuracy: One percent.
 - 5. Scale: Psi.

2.18 PRESSURE GAUGE TAPS

- A. Needle Valve: Brass, 1/4 inch NPT for minimum 300 psi.
- B. Ball Valve: Brass, 1/4 inch NPT for 250 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.

2.19 STEM TYPE THERMOMETERS

- A. Thermometer: ASTM E1, adjustable angle, red appearing indicator, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
 - 4. Accuracy: 2 percent.
 - 5. Calibration: Degrees F.
 - 6. Indicator shall be non-mercury.

2.20 WATER METER

- A. Provide Lead Free water meter and remote reader as recommended by water service provider. Meter to register flow in Gallons. Plumbing Contractor to install meter and reader. Install meter in accordance with AWWA M6, with isolating valves on inlet and outlet.
- B. Obtain meter from water service provider. If not possible, obtain approval of proposed meter from Director of Utility of Water Service Provider prior to water meter purchase.

2.21 HYDRANTS

- A. Wall Hydrant, HYD-1: Lead-Free, interior use, self-draining type with lockable recessed box hose thread spout, locks shield and removable key, and integral vacuum breaker.
- B. Wall Hydrant, HYD-2: Lead-Free, non-freeze, self-draining type with lockable recessed box hose thread spout, locks shield and removable key, and integral vacuum breaker.

2.22 BACKFLOW PREVENTERS

- A. Double Check Valve Assemblies, DCV-1:
 - 1. Comply with ASSE 1012. Lead Free.
 - 2. Bronze body with corrosion resistant internal parts and stainless steel springs.
 - 3. Two independently operating check valves with intermediate atmospheric vent.
 - 4. Provide testing by State certified backflow prevention device tester, and document of Certification.

2.23 WATER HAMMER ARRESTOR -LEAD FREE

- A. Stainless steel bellow type, complies with and sized in accordance with PDI WH-201.
- B. Pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum 150 psi working pressure.

2.24 THERMOSTATIC MIXING VALVE

- A. Valve: Chrome plated cast brass body, stainless steel or nickel plated bellows, integral temperature adjustment.
- B. Accessories:
 - 1. Check valve on inlets.
 - 2. Volume control shut-off valve on outlet.
 - 3. Stem thermometer on outlet.
 - 4. Strainer stop checks on inlets.
- C. Cabinet: 16 gage enameled steel, for surface mounting with keyed lock.

2.25 FLOOR DRAIN / FLOOR SINK

- A. Floor Drain, FD-1: ASME A112.21.1; cast iron two piece body with double drainage flange, weep holes, 1/2 inch trap primer connection, reversible clamping collar, and round adjustable nickel-bronze strainer.
- B. Floor Sink, FS-1: 12 inch x 12 inch x 6 inch floor receptor, full nickel-bronze grate, enamel interior and top, interior bottom dome strainer and 1/2 inch trap primer connection.
- C. Floor Drain / Floor Sink Trap Primer Valve: ASSE 1018, corrosion resistant brass, piston operated, no springs or diaphragms, adjustable in line pressure, 1/2 inch inlet and outlet openings.

2.26 CLEANOUTS

- A. Cleanout, Interior Finished Floor Area, CO-1: cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round polished bronze scoriated cover.
- B. Cleanout, Interior Unfinished Inline Accessible Area, CO-2: cast iron body ferrule type with ABS countersunk plug.
- C. Wall Cleanout, Interior Finished Wall Area, WCO-1: cast iron body with lacquered ABS tapered threaded plug and round stainless steel wall access cover with securing screw.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 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. Protect open ends with temporary plugs or caps.
- C. Prepare piping connections to equipment with flanges or unions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- G. Provide access where valves and fittings are not exposed.
- H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- I. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welding.
- J. Provide support for utility meters in accordance with requirements of utility companies.
- K. Excavate in accordance with Section 31 23 16.
- L. Backfill in accordance with Section 31 23 23.
- M. Trench - Provide 3 inches of sand for bedding material at trench bottom to provide uniform bedding for piping. Level bedding materials and install pipe on prepared bedding. Encase installed piping with 6 inches of pea gravel. Provide fill material to trench and compact to 90 percent maximum density. Route pipe in straight line.
- N. Install bell and spigot pipe with bell end upstream.
- O. Install water piping to ASME B31.9.
- P. 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.
- Q. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- R. Sleeve pipes passing through partitions, walls, and floors.
- S. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- T. PVC piping is not allowed to be installed in places of assembly, plenum spaces, exit discharge corridors or stairs. Use cast iron or copper piping in these locations.
- U. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping.
- V. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to fixtures to prevent hammer or install air chambers on hot and cold water supply piping to each fixture or group of fixtures (each washroom). Fabricate same size as supply pipe or 3/4 inch minimum, and minimum 18 inches long.
- W. 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.
- X. 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.
 10. Support cast iron drainage piping at every joint.
- Y. Pipe Sleeve-Seal Systems:
1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a watertight seal.
 6. Install in accordance with manufacturer's recommendations.
- Z. Equipment Bases and Supports
1. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
 2. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
 3. Construct supports of steel members or formed steel channel. Brace and fasten with flanges bolted to structure.
- AA. Flashing
1. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
 2. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
 3. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
 4. Seal floor, shower, and mop sink drains watertight to adjacent materials.
 5. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.
- BB. Sleeves
1. Set sleeves in position in forms. Provide reinforcing around sleeves.
 2. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
 3. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
 4. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with fire stopping, insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

5. Install chrome plated steel escutcheons at finished surfaces.

3.4 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, branch piping, or vertical risers.
- D. Install globe valves for throttling, bypass, or manual flow control services.

3.5 TOLERANCES

- A. Sanitary Drainage Piping: Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum on mains 4 inches and larger. Install branch mains smaller than 4 inch with 1/4 inch per foot minimum.
- B. Storm Drainage Piping: Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Final water samples shall be sent to a State Department of Health approved testing lab in the State of New York and sample test results shall be submitted to A/E of record.
- B. Prior to starting work, verify system is complete, flushed, and clean.
- C. 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).
- D. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.
- E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- F. Maintain disinfectant in system for 24 hours.
- G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- I. 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.

3.7 SERVICE CONNECTIONS

- A. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve, and sand strainer.
- B. Test sanitary waste, vent piping and storm drainage system in accordance with Plumbing Code of the State of New York.
- C. Test backflow prevention device in accordance with ASSE 5013, by State certified backflow prevention device tester.
 1. Provide test results and Certification of tester.
- D. Test domestic water piping system in accordance with Plumbing Code of the State of New York.
- E. Provide new gas piping into building. Building gas service distribution piping to have pressure of [1/2] psi.

- F. Test 1/2 psi gas piping system at 10 psi for one hour in accordance with Fuel Gas Code of the State of New York and New York State SED Manual of Planning Standards.

3.8 SCHEDULES

- A. Pipe Hanger Spacing:
1. Metal Piping:
 - a. Pipe Size: 1/2 inch to 1-1/4 inch:
 - 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inch to 2 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inch to 3 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inch to 6 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.
 2. Cast Iron (All Sizes) pipe length less than 10':
 - a. Maximum hanger Spacing: 5 ft.
 - b. Hanger rod diameter: 5/8 inch
 3. Cast Iron (All Sizes) with 10 foot length of pipe
 - a. Maximum hanger Spacing: 10 ft.
 - b. Hanger rod diameter: 5/8 inch
 4. CPVC, 1 inch and smaller
 - a. Maximum hanger Spacing: 3 ft.
 - b. Hanger rod diameter: 1/2 inch
 5. CPVC, 1-1/4 inches and larger
 - a. Maximum hanger Spacing: 4 ft.
 - b. Hanger rod diameter: 1/2 inch
 6. Copper Tube, 1-1/4 inches and smaller
 - a. Maximum hanger Spacing: 6 ft.
 - b. Hanger rod diameter: 1/2 inch
 7. Copper Tube, 1-1/2 inches and larger
 - a. Maximum hanger Spacing: 10 ft.
 - b. Hanger rod diameter: 1/2 inch
 8. PVC (All Sizes)
 - a. Maximum hanger Spacing: 4 ft.
 - b. Hanger rod diameter: 3/8 inch

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Commercial electric water heaters.
- B. Water filters.
- C. UV sterilizers.

1.2 REFERENCE STANDARDS

- A. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- B. UL 174 - Standard for Household Electric Storage Tank Water Heaters; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Provide electrical characteristics and connection requirements.
- C. Shop Drawings:
 - 1. Indicate heat exchanger dimensions, size of tappings, and performance data.
 - 2. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, tappings, and drains.
- D. Project Record Documents: Record actual locations of components.
- 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.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

1.4 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. Certifications:
 - 1. Water Heaters: NSF approved.
 - 2. Electric Water Heaters: UL listed and labeled to UL 174.
 - 3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.
- B. Accept water heaters on site in original labeled cartons. Inspect for damage.

1.6 WARRANTY

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

PART 2 PRODUCTS

2.1 WATER HEATERS

- A. Manufacturers:
 - 1. A.O. Smith Water Products Co: www.hotwater.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 WATER FILTERS

- A. Manufacturers:
 - 1. Pentek P Series.
- B. Commercial:
 - 1. Filter Media: 5 Micron Cartridge.
 - 2. Tank: Pentek Big Blue tank.
 - 3. Flow Rate: 10 gpm.
 - 4. Provide capped backwash, carbon refill, and sediment removal access.
 - 5. Potable Water Service: NSF 61 certified.

2.3 UV STERILIZERS

- A. Manufacturers:
 - 1. Atlantic Ultraviolet Company S37CSanitron .
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Performance:
 - 1. Water Flow Rate: 12 gpm.
- C. Construction:
 - 1. Reactor Chamber Material: 316L stainless steel or 304 stainless steel.
 - 2. Lamp type consists of low pressure mercury.
- D. Controls: Open loop current control with detachable power cord, audible alarm, and power on indicators.
- E. NSF 55 and NSF 61 certified

2.4 DOMESTIC PUMPS

- A. Domestic Pump, Recirculation, DP-1: UL and CSA listed, rated for 140 psig maximum working pressure, bronze or stainless steel casing, polypropylene (glass filled) impeller, stainless steel shaft, graphite bearing, EPDM gasket and aquastat
- B. Electrical requirements:
 - 1. As indicated on Drawing.

PART 3 EXECUTION

3.1 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 Water Heater:
 - 1. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater on each side. Refer to Section 03 30 00.
 - 2. Maintain manufacturer's recommended clearances around and over water heaters.
 - 3. Connect natural gas piping in accordance with NFPA 54.
 - 4. Connect natural gas piping to water heater, full size of water heater gas train inlet. Arrange piping with clearances for burner removal and service.
 - 5. Connect domestic hot water piping to outlet connection and connect domestic hot water recirculation piping to domestic cold water piping. Connect cold water piping to inlet connections.
 - 6. Install the following piping accessories.
 - a. On supply:
 - 1) Thermometer well and thermometer.
 - 2) Strainer.
 - 3) Pressure gage.
 - 4) Shutoff valve.
 - b. On return:
 - 1) Thermometer well and thermometer.
 - 2) Pressure gage.
 - 3) Shutoff valve.
 - c. Install the following piping accessories on natural gas piping connections. Refer to Section 22 10 05.
 - 1) Strainer.
 - 2) Pressure gage.
 - 3) Shutoff valve.
 - 4) Pressure reducing valve.
 - 7. Install discharge piping from relief valves and drain valves to nearest floor drain.
 - 8. Install circulator and diaphragm expansion tank on water heater.
 - 9. Install water heater trim and accessories furnished loose for field mounting.
 - 10. Install electrical devices furnished loose for field mounting.
 - 11. Install control wiring between water heater control panel and field mounted control devices.
 - 12. Connect CPVC flue to water heater outlet, full size of outlet.
 - 13. Install Work in accordance with applicable Plumbing Code of the State of New York.
- D. Domestic Water Heat Exchangers:
 - 1. Install domestic water heat exchangers with clearance for tube bundle removal without disturbing other installed equipment or piping.
 - 2. Pipe relief valves and drains to nearest floor drain.
- E. Domestic 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.
- F. Domestic Water Softeners
 - 1. Coordinate with plumbing piping and electrical Work to achieve operating system.
 - 2. Install piping accessories, as noted below but not limited to, on water conditioning equipment for 140 degree domestic hot water piping per manufacturer's recommendation.
 - a. On inlet:
 - 1) Shut-off valve.
 - b. On outlet:
 - 1) Shut-off valve.
 - 3. Install drain piping from tanks to nearest floor drain.

4. Install water softener on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water softener equipment on each side. Refer to Section 03 30 00.

END OF SECTION

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Flush valve water closets.
- B. Wall hung urinals.
- C. Lavatories.
- D. Wall-hung, solid surface, multistation lavatory units.
- E. All-in-one lavatory system.
- F. Sinks.
- G. Under-lavatory pipe supply covers.
- H. Shower receptors.
- I. Showers.
- J. Outdoor showers.
- K. Electric water coolers.
- L. Service sinks.
- M. Emergency eye and face wash.
- N. Emergency showers.

1.2 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping and Specialties.
- B. Section 22 30 00 - Plumbing Equipment.
- C. Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.

1.3 REFERENCE STANDARDS

- A. ASHRAE Std 18 - Methods of Testing for Rating Drinking-Water Coolers with Self-Contained Mechanical Refrigeration; 2008 (Reaffirmed 2013).
- B. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use; 1997 (Reaffirmed 2017).
- C. ASME A112.18.1 - Plumbing Supply Fittings; 2024.
- D. ASME A112.19.2 - Ceramic Plumbing Fixtures; 2024.
- E. ASME A112.19.3 - Stainless Steel Plumbing Fixtures; 2022.
- F. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks; 2022.
- G. IAPMO Z124 - Plastic Plumbing Fixtures; 2022, with Editorial Revision.

- H. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- I. ISFA 2-01 - Classification and Standards for Solid Surfacing Material; 2013.
- J. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- K. NSF 372 - Drinking Water System Components - Lead Content; 2024.
- L. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.
 - 2. Flush Valve Service Kits: One for each type and size.

1.5 QUALITY ASSURANCE

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

1.6 REGULATORY REQUIREMENTS

- A. Plumbing piping, joints, faucets, etc. must comply with the requirements, and bear the label indicating the materials comply with the definition of "lead free" requirement of the Environmental Protection Agency "Reduction of Lead in Drinking Water Act".
- B. Lead Water Testing: Lead water testing shall be conducted at all Lavatories, Sinks and Drinking Fountains in accordance with Public Health Law section 1370-a and 1110, Subpart 67-4 of Title 10 (Health) of the Official Compilation of Codes, Rules and Regulations of the State of New York and the Environmental Protection Agency 3T's for Reducing Lead in Drinking Water.
- C. School District reserves the right to accept or not accept installation unless results are not greater than the Department Of Health action level.

1.7 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.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Provide standard manufacturer warranty for Plumbing Fixtures.

PART 2 PRODUCTS

2.1 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.

2.2 MANUFACTURERS:

- A. Refer to Plumbing Fixture Schedule on drawing for Manufacturer, Model, Trim and Remarks.

2.3 FLUSH VALVE WATER CLOSETS

- A. Water Closet Bowl (WC-): ASME A112.19.2; ADA compliant, wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.28 gallon flush volume.
- B. Water Closet Bowl (WC-): ASME A112.19.2; Wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.28 gallon flush volume.
- C. Water Closet Bowl (WC-): ASME A112.19.2; ADA compliant, 16-1/2 inch rim height, floor mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.28 gallon flush volume.
- D. Water Closet Bowl (WC-): ASME A112.19.2; 15 inch rim height, floor mount, siphon jet, vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud and 1.28 gallon flush volume.
- E. Water Closet Bowl (WC-): ASME A112.19.2; Child ADA compliant, 10-3/4 inch rim height, floor mount, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.28 gallon flush volume.
- F. Water Closet Bowl (WC-): ASME A112.19.2; Child 10-3/4 inch rim height, floor mount, vitreous china closet bowl with elongated rim, 1-1/2 inch top spud and 1.28 gallon flush volume.
- G. Water Closet Bowl (WC-): ASME A112.19.2; ADA compliant, wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch back spud and 1.28 gallon flush volume.
- H. Water Closet Bowl (WC-): ASME A112.19.2; Wall mount, siphon jet, vitreous china closet bowl with elongated rim, 1-1/2 inch back spud and 1.28 gallon flush volume.
- I. Flush Valve, Manually Operated (WC-): ADA compliant, exposed chrome plated, diaphragm type with oscillating handle, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.28 gallon flush volume for use with 1-1/2 inch top spud.
- J. Flush Valve, Electric Powered Sensor Operated (WC-): ADA compliant, exposed chrome plated diaphragm type with solenoid operator with one wall cover plate. Adaptive infrared sensor and true mechanical over-ride button, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.28 gallon flush volume for use with 1-1/2 inch top spud.
 - 1. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- K. Flush Valve, Solar Powered Sensor Operated (WC-): ADA compliant, exposed chrome plated diaphragm type with solenoid operator, flushing with battery back-up power source. Adaptive infrared sensor, 72-hour sentinel flush, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.28 gallon flush volume for use with 1-1/2 inch top spud.
- L. Flush Valve, Hydropower Self-Generating Sensor (WC-): ADA compliant, exposed chrome plated, piston valve. Adaptive infrared sensor, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.28 gallon flush volume for use with 1-1/2 inch top spud. Flushing shall recharge valve.
- M. Flush Valve, Battery Powered Sensor Operated (WC-): ADA compliant, exposed side mount chrome plated diaphragm type with infrared sensor, flush with four size C battery power source, escutcheon, seat bumper, integral screwdriver stop, vacuum breaker and 1.28 gallon flush volume for use with 1-1/2 inch top spud.

- N. Flush Valve, Concealed Electric Powered Sensor Operated (WC-): ADA compliant, concealed rough brass diaphragm type with solenoid operator with wall box with stainless steel access panel and vandal resistant screws. Adaptive infrared sensor and true mechanical over-ride button, stop seat, integral wheel handle stop, vacuum breaker and 1.28 gallon flush volume for use with 1-1/2 inch back spud.
 - 1. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- O. Toilet Seats:
 - 1. Elongated solid white plastic, open front without cover, self-sustaining hinge, brass bolts.
 - 2. Elongated solid white seat and hinges, open front without cover, scalloped handhold for use with child floor mounted water closet.
- P. Water Closet Carriers:
 - 1. ASME A112.6.1M; floor mounted, adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor attachment, threaded fixture studs with nuts and washers. For handicap and non-handicap wall mount water closets.
- Q. Water Closet Accessories:
 - 1. Toilet mounting flange, bowl ring, mounting hardware, bolt caps. For handicap and non-handicap floor mounted water closets.

2.4 WALL HUNG URINALS

- A. Urinal, (UR-1, UR-2): ASME A112.19.2; ADA compliant, wall mount, washout, vitreous china urinal with shields, integral trap, elongated 14 inch rim from finished wall, 3/4 inch top spud, steel supporting hanger and 0.50 gallon flush volume.
- B. Urinal, (UR1-, UR-2): ASME A112.19.2; ADA compliant, wall mount, washout, vitreous china urinal with shields, integral trap, elongated 14 inch rim from finished wall, 3/4 inch back spud, steel supporting hanger and 0.50 gallon flush volume.
 - 1. Flush Volume: 0.5 gallons, maximum.
 - 2. Flush Valve: Exposed (top spud).
 - 3. Flush Operation: Sensor operated.
 - 4. Trapway Outlet: Integral.
- C. Flush Valve, Manually Operated (UR-): ADA compliant, exposed chrome plated, diaphragm type with oscillating handle, escutcheon, integral screwdriver stop, vacuum breaker and 0.50 gallon flush volume for use with 3/4 inch top spud.
- D. Flush Valve, Electric Powered Sensor Operated (UR-): ADA compliant, exposed chrome plated diaphragm type with solenoid operator with one wall cover plate. Adaptive infrared sensor, true mechanical over-ride button, escutcheon, integral screwdriver stop, vacuum breaker and 0.50 gallon flush volume for use with 3/4 inch top spud.
 - 1. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- E. Flush Valve, Solar Powered Sensor Operated (UR-) : ADA compliant, exposed chrome plated diaphragm type with solenoid operator, flushing with battery back-up power source. Adaptive infrared sensor, 72-hour sentinel flush, escutcheon, integral screwdriver stop, vacuum breaker and 0.50 gallon flush volume for use with 3/4 inch top spud.
- F. Flush Valve, Hydropower Self-Generating Sensor (UR-): ADA compliant, exposed chrome plated, piston valve. Adaptive sensor and over-ride button, escutcheon, integral screwdriver stop, vacuum breaker and 0.50 gallon flush volume for use with 3/4 inch top spud. Flushing shall recharge valve. Battery backup.
- G. Flush Valve, Battery Powered Sensor Operated (UR-): ADA compliant, exposed side mount chrome plated diaphragm type with infrared sensor, flush with four size C battery power source, escutcheon, integral screwdriver stop, vacuum breaker and 0.50 gallon flush volume for use with 3/4 inch top spud.

- H. Flush Valve, Concealed Electric Powered Sensor Operated (UR-): ADA compliant, concealed rough brass diaphragm type with solenoid operator with wall box with stainless steel access panel and vandal resistant screws. Adaptive infrared sensor, true mechanical over-ride button, integral wheel handle stop, vacuum breaker and 0.50 gallon flush volume for use with 3/4 inch back spud.
 - 1. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- I. Urinal Carriers:
 - 1. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor attachment, threaded fixture studs for fixture hanger, bearing studs. For handicap and non-handicap urinals.

2.5 LAVATORIES

- A. Lavatory, Vitreous China Wall Mount Basin (LAV-): ASME A112.19.2; ADA compliant, vitreous china wall mount, 20 x 18 inch minimum, with 4 inch high back, single hole faucet mount drilling, D-shaped basin with splash lip, front overflow and grid drain. For handicap and non-handicap lavatories. Provide offset grid drain and pipe covers for handicap lavatory.
- B. Lavatory, Vitreous China Wall Mount Basin (LAV-): ASME A112.19.2; ADA compliant, vitreous china wall mount, 20 x 18 inch minimum, with 4 inch high back, 3-hole faucet mount drilling, D-shaped basin with splash lip, front overflow and grid drain. For handicap and non-handicap lavatories. Provide offset grid drain and pipe covers for handicap lavatory.
- C. Lavatory, Multiple Integral Solid Surface Countertop and Bowls: ANSI Z124.3, Z124.6, ANSI/ICPA SS-1-2001, ADA compliant, chemical resistant, solid surface countertop with integral bowls. Number of bowls as shown on drawings. Provide single hole faucet mount drilling, front and side aprons, backsplash, deck mounted soap dispensers, soap bottles, grid drain and stainless steel trap covers. Submit color chart that includes standard colors and designer colors for selection by Architect. Provide stainless steel trap cover for each handicap and non-handicap bowl.
- D. Manual Faucet: ASME A112.18.1: ADA compliant, low lead content, 4 inch on center mount, chrome finish, maximum 0.50 gpm flow of 60 psig, color coded wristblade handles.
- E. Metered Faucet: ASME A112.18.1: ADA compliant, low lead content, 4 inch on center mount, self closing push handles, chrome finish, maximum 0.50 gpm flow of 60 psig or metering at maximum 0.20 gallons per cycle, color coded push handles.
- F. Electric Powered Sensor Faucet: ADA compliant, low lead content, tempered water connection, chrome finish, maximum 0.50 gpm flow of 60 psig, 4 inch cover plate, transformer (hard wired) and lead-free thermostatic mixing valve.
 - 1. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- G. Solar Powered Sensor Faucet: ASME A112.18.1: ADA compliant, low lead content, single hole mount, tempered water connection, chrome finish, battery back-up power source, maximum 0.50 gpm multi-stream flow of 60 psig and lead-free thermostatic mixing valve.
- H. Hydropower Self-Generating Sensor Faucet: ASME A112.18.1: ADA compliant, low lead content, single hole mount, tempered water connection, chrome finish, maximum 0.20 gpm per 10 second cycle, lead-free thermostatic mixing valve, controller, mixer. Controller components housed in waterproof compartment.
- I. Battery Powered Sensor Faucet: ASME A112.18.1: ADA compliant, low lead content, 4 inch on center mount, tempered water connection, chrome finish, maximum 0.50 gpm flow of 60 psig, 4 inch trim plate, lead-free thermostatic mixing valve.
- J. Wall Mounted Carrier: ASME A112.6.1; Cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, concealed arm supports, bearing plate and studs. For handicap and non-handicap lavatories.

2.6 SINKS

- A. Combination Sink With Separate Bubbler Basin, Sink, ADA Compliant, 16" W X 11-1/2" L X 5-1/2" D, Right Side Bubbler Basin, ADA Compliant, 9-1/2" W X 12-1/2" L X 3-1/2" D, Countertop Mount, stainless steel.
 - 1. Trim: Deck mounted low lead content mixing faucet, 11 inch high spout with 2.2 gpm aerator, chrome plated finish with 4 inch wristblade handles.
 - 2. Bubbler: Lead-Free, self closing push button, 304 stainless steel.
 - 3. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.
 - 4. Refer to Plumbing Fixture Schedule on drawing for location of drinking fountain.
- B. Single Compartment Bowl: ASME A112.19.3; 19 x 21 x 5-1/2 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel offset grid drain and tailpiece and ledge back drilled for trim.
 - 1. Trim: Deck mounted low lead content mixing faucet, 11-5/8 inch high spout with 2.20 gpm aerator, chrome plated finish with single lever handle.
 - 2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.
- C. Single Compartment Bowl: ASME A112.19.3; 19 x 21 x 5-1/2 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel offset grid drain and tailpiece, transformer, thermostatic mixing valve and ledge back drilled, single hole, for trim.
 - 1. Trim: Deck mounted low lead content sensor faucet, 11-5/8 inch high spout with 2.20 gpm aerator, chrome plated finish.
 - 2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.
 - 3. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
 - b. Transformer (Hard Wired): 120V AC Input / 12V AC Output / 300 mA Output Current.
- D. Single Compartment Bowl: ASME A112.19.3; 19 x 21 x 10-1/2 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel grid drain and tailpiece and ledge back drilled for trim.
 - 1. Trim: Deck mounted low lead content mixing faucet, 13-1/8 inch high spout with 2.20 gpm aerator, chrome plated finish with 4 inch wristblade handles.
 - 2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.
- E. Single Compartment Bowl: ASME A112.19.3; 22 x 31 x 11-1/2 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel grid drain and tailpiece and ledge back drilled for trim.
 - 1. Trim: Deck mounted low lead content mixing faucet, 13-1/8 inch high spout with 2.20 gpm aerator, chrome plated finish with 4 inch wristblade handles.
 - 2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.
- F. Double Compartment Bowl: ASME A112.19.3; 21 x 33 x 5-1/2 inch outside dimensions 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel offset crumb cups drain and tailpiece, ledge back drilled for trim.
 - 1. Trim: Deck mounted low lead content mixing faucet, 6 inch high spout with 2.20 gpm aerator, chrome plated finish with single lever handle.
 - 2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.
- G. Single Compartment Bowl: ASME A112.19.3; 21 x 25 x 8 inch outside dimensions, 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch stainless steel grid drain and tailpiece and ledge back drilled for trim.

1. Trim: Deck mounted low lead content mixing faucet, 13-1/8 inch high spout with 2.20 gpm aerator, chrome plated finish with 4 inch wristblade handles.
2. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, screwdriver stop and rigid supplies.

2.7 SHOWERS

- A. Trim: ADA, transfer shower cabinet enclosure, 1.50 GPM wall hung showerhead, 1.50 GPM hand held shower with stainless steel hose, vacuum breaker, grab bars, folding seat, thermostatic mixing control valve, soap dish, terrazzo floor with stainless steel entry cap, curtain rod, curtain and holder.
- B. Trim: Recess-mounted ADA wall unit, stainless steel panel, adjustable 1.50 GPM showerhead, 1.50 GPM hand held shower with stainless steel hose, backflow preventer, diverter valve, grab bars, phenolic folding seat, thermostatic mixing control valve, curtain rod, curtain and holder.
- C. Trim: ADA, Acrylic shower cabinet enclosure, 1.50 GPM hand held shower set with slide bar, vacuum breaker, grab bars, folding seat, thermostatic mixing control valve, 120V LED dome light, soap dish, curtain rod, curtain and holder.
- D. Trim: Flush mounted wall unit, stainless steel panel, fixed direction adjustable 1.50 GPM showerhead, soap dish, thermostatic mixing control valve.

2.8 ELECTRIC WATER COOLERS

- A. Water Cooler (EWC-): Lead-Free, Electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, stainless steel body, elevated lead-free 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. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- B. Water Cooler, (EWC-): Lead-Free, ADA compliant, Two-station, electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, stainless steel body, elevated lead-free anti-squirt bubbler with stream guard, automatic stream regulator, push controls located in front, left and right side of unit, mounting bracket; integral air cooled condenser, cane apron for upper unit. Body and lower shroud to be stainless steel.
 1. Capacity: 8 gallons per minute 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 requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.
- C. Water Cooler with Bottle Filler, (ECB-): Lead-Free, ADA compliant Single-station, electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, stainless steel body, elevated lead-free anti-squirt bubbler with stream guard, automatic stream regulator, push controls located in front, left and right side of unit, mounting bracket; integral air cooled condenser. Body and lower shroud to be stainless steel. Bottle filler with filter and electronic sensor activation, plastic components, visual monitor for filter replacement. Provide 3-pack replacement filters.
 1. Capacity: Water Cooler - 8 gallons per minute 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.
Capacity: Bottle Filler - 1.1 -1.5 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
 2. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.

- D. Water Cooler with Bottle Filler, (ECB-): Lead-Free, ADA compliant Two-station, electric, mechanically refrigerated; surface handicapped mounted; stainless steel top, stainless steel body, elevated lead-free anti-squirt bubbler with stream guard, automatic stream regulator, push controls located in front, left and right side of unit, mounting bracket; integral air cooled condenser, cane apron. Body and lower shroud to be stainless steel. Bottle filler with filter and electronic sensor activation, plastic components, visual monitor for filter replacement. Provide 3-pack replacement filters.
 - 1. Capacity: Water Cooler - 8 gallons per minute 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.
Capacity: Bottle Filler - 1.1 - 1.5 gallons per minute of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
 - 2. Electrical requirements:
 - a. Refer to Plumbing Fixture Schedule on drawing.

2.9 SERVICE SINKS

- A. Manufacturers:
 - 1. EL Mustee; 19CF Utilatub: www.mustee.com.
 - 2. Or Approved Equal.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Bowl: IAPMO Z124; Single Compartment Tub, 20 x 24 x 14 inches overall, one-piece molded from structural thermoplastics with integrally molded drain assembly, self draining back shelf, and heavy gauge steel legs with adjustable levelers.
- C. Trim: ASME A112.18.1 exposed back shelf mounted supply with 6 inch swing spout, 20 inch flexible supply lines, 1.5 inch PVC P-Trap, and drain stopper.

2.10 MOP SINKS

- A. Bowl: 24 x 24 x 12 inch high molded stone, floor mounted with not less than 1 1/2 inch wide shoulder, stainless steel cap, stainless steel strainer.
 - 1. Trim: Lead-Free, recessed wall type supply with handles, spout wall brace, vacuum breaker, hose end spout, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
 - 2. Accessories:
 - a. Hose clamp hanger.
 - b. Mop hanger.
 - c. Stainless Steel Wall Guards.

2.11 EMERGENCY EYE AND FACE WASH

- A. Emergency Wash EW-1: ANSI Z358.1; free standing, eye [<>] wash with quick opening, full-flow valves, ABS eye [<>] wash receptor, twin eye wash heads with plastic dust cover [<>], [<>] copper alloy control valve and fittings. Furnish universal emergency sign and ANSI Z358.1 compliant thermostatic mixing valve tempered water blending system.
- B. Emergency Wash, EW-2: ADA compliant, ANSI Z358.1; countertop sink mounted pull down eyewash with quick opening, full-flow valves, copper alloy control valve and fittings. Furnish universal emergency sign and ANSI Z358.1 compliant thermostatic mixing valve tempered water blending system with temperature gauge.
- C. Cabinet: Stainless steel, for surface mounting with keyed lock.
- D. Cabinet: Stainless steel, for recess mounting with keyed lock.

2.12 EMERGENCY SHOWERS

- A. ANSI Z358.1; Combination pedestal mounted, plastic showerhead and plastic bowl. 1-1/4 inch galvanized steel pipe pedestal with floor flange, instant action stay open valve actuated by lever or push flag, Eye wash with twin spray heads, dust cover assembly. Furnish universal emergency sign and ANSI Z358.1 compliant thermostatic mixing valve blending system.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 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.

3.4 INTERFACE WITH WORK OF OTHER SECTIONS

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

3.5 ADJUSTING

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

3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

3.7 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Do not permit use of fixtures by construction personnel.
- C. Repair or replace damaged products before Date of Substantial Completion.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Stencils.
- D. Ceiling tacks.

1.2 RELATED REQUIREMENTS

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

1.3 REFERENCE STANDARDS

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- D. Product Data: Provide manufacturers catalog literature for each product required.
- E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- F. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Automatic Controls: Tags. Key to control schematic.
- D. Control Panels: Nameplates.
- E. Dampers: Ceiling tacks, where located above lay-in ceiling.
- F. Ductwork: Stencilled painting.

- G. Major Control Components: Nameplates.
- H. Piping: Tags.
- I. Pumps: Nameplates.
- J. Small-sized Equipment: Tags.
- K. Tanks: Nameplates.
- L. Thermostats: Nameplates.
- M. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- N. Water Treatment Devices: Nameplates.

2.2 NAMEPLATES

- A. Manufacturers:
 - 1. Advanced Graphic Engraving, LLC: www.advancedgraphicengraving.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
 - 4. Letter Color: White.
 - 5. Letter Height: 1/2 inch.
 - 6. Background Color: Black.

2.3 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter.
- C. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- D. Valve Tag Chart: Typewritten letter size list of applied tags and locations in plastic laminated frame.

2.4 STENCILS

- A. Manufacturers:
 - 1. Brady Corporation: www.bradycorp.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 - 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
 - 6. Ductwork and Equipment: 2-1/2 inch high letters.

- C. Stencil Paint: As specified in Section 09 91 23, semi-gloss enamel, colors complying with ASME A13.1.

2.5 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.
 - 4. Plumbing valves: Green

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 91 23.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install 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.
- F. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

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

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic, steam, and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Sound measurement of equipment operating conditions.
- E. Commissioning activities.

1.2 RELATED REQUIREMENTS

- A. Section 01 40 00 - Quality Requirements: Employment of testing agency and payment for services.
- B. Section 23 08 00 - Commissioning of HVAC.

1.3 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024.
- C. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2019, with Errata (2022).
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Submit to Architect.
 - 2. Submit to the project engineer / Commissioning Authority.
 - 3. Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - 4. Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - 5. Include at least the following in the plan:
 - a. Preface: An explanation of the intended use of the control system.
 - b. 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.
 - c. 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.

- d. Identification and types of measurement instruments to be used and their most recent calibration date.
 - e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - f. Final test report forms to be used.
 - g. Detailed step-by-step procedures for TAB work for each system and issue, including:
 - 1) Terminal flow calibration (for each terminal type).
 - 2) Diffuser proportioning.
 - 3) Branch/submain proportioning.
 - 4) Total flow calculations.
 - 5) Rechecking.
 - 6) Diversity issues.
 - h. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Field Logs: Submit at least once a week to project engineer / Commissioning Authority.
- E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- F. Progress Reports.
- G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- 1. Submit to the project engineer / Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
 - 2. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 4. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 5. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 6. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
- H. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Maintain one copy of each document on site.
- C. Prior to commencing Work, calibrate each instrument to be used.

1.7 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC or Certified by NEBB.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.10 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- D. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Having minimum of three years documented experience.
 - 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- E. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.2 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.

9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. 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.

3.3 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect and project engineer / Commissioning Authority to facilitate spot checks during testing.

3.4 ADJUSTMENT TOLERANCES

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

3.5 RECORDING AND ADJUSTING

- A. Field Logs: Maintain written logs including:
1. Running log of events and issues.
 2. Discrepancies, deficient or uncompleted work by others.
 3. Contract interpretation requests.
 4. Lists of completed tests.
- B. Ensure recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.

- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. 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. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- J. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- K. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.
- L. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- M. 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.

3.7 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.

3.8 COMMISSIONING

- A. See Section 23 08 00 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Furnish to the project engineer / Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.

- D. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 20 percent of the air handlers plus a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- E. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 - 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.
- F. No seasonal tests are required.
- G. No further monitoring is required.
- H. No deferred testing is required.

3.9 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Air Cooled Refrigerant Condensers.
 - 2. Packaged Roof Top Heating/Cooling Units.
 - 3. Terminal Heat Transfer Units.
 - 4. Air Handling Units.
 - 5. Fans.
 - 6. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 - 1. Manufacturer.
 - 2. Model/Frame.
 - 3. HP/BHP.

4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. Air Cooled Condensers:
1. Identification/number.
 2. Location.
 3. Manufacturer.
 4. Model number.
 5. Serial number.
 6. Entering DB air temperature, design and actual.
 7. Leaving DB air temperature, design and actual.
 8. Number of compressors.
- C. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Saturated suction temperature, design and actual.
 11. Air pressure drop, design and actual.
- D. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- E. Air Moving Equipment:
1. Location.
 2. Manufacturer.
 3. Model number.
 4. Serial number.
 5. Arrangement/Class/Discharge.
 6. Air flow, specified and actual.
 7. Return air flow, specified and actual.
 8. Outside air flow, specified and actual.
 9. Total static pressure (total external), specified and actual.
 10. Inlet pressure.
 11. Discharge pressure.
 12. Sheave Make/Size/Bore.
 13. Number of Belts/Make/Size.
 14. Fan RPM.

- F. Return Air/Outside Air:
 - 1. Identification/location.
 - 2. Design air flow.
 - 3. Actual air flow.
 - 4. Design return air flow.
 - 5. Actual return air flow.
 - 6. Design outside air flow.
 - 7. Actual outside air flow.
 - 8. Return air temperature.
 - 9. Outside air temperature.
 - 10. Required mixed air temperature.
 - 11. Actual mixed air temperature.
 - 12. Design outside/return air ratio.
 - 13. Actual outside/return air ratio.
- G. Exhaust Fans:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Air flow, specified and actual.
 - 6. Total static pressure (total external), specified and actual.
 - 7. Inlet pressure.
 - 8. Discharge pressure.
 - 9. Sheave Make/Size/Bore.
 - 10. Number of Belts/Make/Size.
 - 11. Fan RPM.
- H. Duct Traverses:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.
 - 9. Air temperature.
 - 10. Air correction factor.
- I. Duct Leak Tests:
 - 1. Description of ductwork under test.
 - 2. Duct design operating pressure.
 - 3. Duct design test static pressure.
 - 4. Duct capacity, air flow.
 - 5. Maximum allowable leakage duct capacity times leak factor.
 - 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 - 7. Test static pressure.
 - 8. Test orifice differential pressure.
 - 9. Leakage.
- J. Air Monitoring Stations:
 - 1. Identification/location.
 - 2. System.

3. Size.
4. Area.
5. Design velocity.
6. Design air flow.
7. Test velocity.
8. Test air flow.

K. Air Distribution Tests:

1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

L. Sound Level Reports:

1. Location.
2. Octave bands - equipment off.
3. Octave bands - equipment on.

END OF SECTION

SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.

1.2 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 09 91 23 - Interior Painting: Painting insulation jackets.
- C. Section 23 05 53 - Identification for HVAC Piping and Equipment.

1.3 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 C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2013 (Reapproved 2019).
- C. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation; 2020.
- D. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2019.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- F. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2023.
- G. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- H. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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 necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 28 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure-sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.3 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
- B. 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.

C. Vapor Barrier Tape:

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure-sensitive rubber-based adhesive.

2.4 DUCT LINER

A. Manufacturers:

1. CertainTeed Corporation: www.certainteed.com/#sle.
2. Johns Manville: www.jm.com/#sle.

B. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; flexible blanket, rigid board, and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.

1. Fungal Resistance: No growth when tested according to ASTM G21.
2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
3. Service Temperature: Up to 250 degrees F.
4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.

C. Adhesive: Waterproof, fire-retardant type, ASTM C916.

D. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Ducts Conveying Air Below Ambient Temperature:
- C. Insulated Ducts Conveying Air Above Ambient Temperature:
- D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- E. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with caulked aluminum jacket with seams located on bottom side of horizontal duct section.
- 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. 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.
 3. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 4. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- 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.

3.3 SCHEDULES

- A. Exhaust Ducts Within 10 ft of Exterior Openings:
 1. 1" rigid liner.
- B. Outside Air Intake Ducts:
 1. 1" rigid in exposed locations.
 2. 2" flexible for concealed.
- C. Supply and Return Ducts:
 1. 1" rigid liner for exposed applications.
 2. 2" flexible for concealed.
 3. 2" rigid for mechanical rooms.
- D. Exterior duct:
 1. 2" rigid finished with aluminum duct jacket.
- E. Ducts within 10 ft of fans:
 1. 1" rigid liner upstream and downstream of fan.
- F. Relief ductwork within 10 ft of exterior opening:
 1. 1" rigid liner in exposed applications.
 2. 2" flexible for concealed.
- G. Transfer ducts:
 1. 1" rigid liner.

END OF SECTION

SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
- B. Section 07 84 00 - Firestopping.
- C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
- D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.3 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 C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2023.
- C. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2022a.
- D. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation; 2022.
- E. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2023).
- 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; 2023.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 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

2.1 REGULATORY REQUIREMENTS

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

2.2 GLASS FIBER, RIGID

- A. 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.
- B. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 650 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- E. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.3 CELLULAR GLASS

- A. Block Insulation: ASTM C552, Type I, Grade 6.
 - 1. K Value: 0.35 at 100 degrees F.
 - 2. Service Temperature: 800 degrees F, maximum.
 - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.

2.4 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Armacell LLC: www.armacell.us/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.

HVAC PIPING INSULATION

1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 180 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. All fittings shall be constructed of like material and sealed per insulation manufacturer recommendations. Fiberglass insulation with fitting covers shall not be accepted.

2.5 JACKETING AND ACCESSORIES

- A. PVC Plastic.
1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - b. Knauf: www.knaufnorthamerica.com.
 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.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Exposed Piping: Locate insulation and cover seams in least visible locations.
- D. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- E. 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.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, see Section 07 84 00.
- J. Pipe Exposed in Mechanical Equipment and Storage Rooms (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- K. Pipe Exposed in Finished Spaces: Finish with PVC jacket and fitting covers.
- L. 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.

3.3 SCHEDULE

- A. Heating Systems:
1. Heating Water Supply and Return: Glass Fiber Insulation:
 - a. Pipe sizes 1/2" to 1-1/4" = 1-1/2" thick.
 - b. Pipe sizes 1-1/2" and greater = 2" thick.
- B. Cooling Systems:
1. Condensate Drains from Cooling Coils: Flexible Elastomeric Cellular Insulation; All pipe sizes = 1 1/2" thick.
 2. All Refrigerant Piping: Flexible Elastomeric Cellular Insulation; All pipe sizes = 1 1/2" thick.

END OF SECTION

SECTION 23 08 00
COMMISSIONING OF HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. 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 demonstrating proper operation to the commissioning authority. A commissioning authority who is hired by the Owner shall supervise and approve all commissioning activities.
- B. The Commissioning Authority (CA) directs and coordinates all commissioning activities and provides Prefunctional Checklists and Functional Test Procedures for Contractor's use.
- C. The following HVAC equipment is to be commissioned, including commissioning activities for the following specific items:
 - 1. HVAC controls, including equipment / system sequences of operations.
 - 2. DDC front-end controls graphics.
 - 3. Air handling units and associated controls.
 - 4. Split-system air conditioning units.
 - 5. Exhaust fans and EF systems.
 - 6. Major and minor equipment items.
 - 7. Piping systems and equipment.
 - 8. Ductwork and accessories.
 - 9. Terminal units.
 - 10. Service water heating system
 - 11. Lighting control systems
 - 12. Other equipment and systems explicitly identified elsewhere in Contract Documents as requiring commissioning.
- D. 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.

1.2 RELATED REQUIREMENTS

- A. Section 01 78 00 - Closeout Submittals: Scope and procedures for operation and maintenance manuals and project record documents.
- B. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 23 09 93 - Sequence of Operations for HVAC Controls.

1.3 REFERENCE STANDARDS

- A. ASHRAE Guideline 1.1 - Application of the Commissioning Process to New HVAC&R Systems; 2025.

1.4 SUBMITTALS

- A. Updated Submittals: Keep the Owner, Owner's representative, and project engineer, and Commissioning Authority informed of all changes to control system documentation made during programming and setup; revise and resubmit when substantial changes are made.
- B. Startup Reports, Prefunctional Checklists, and Trend Logs: Submit for approval of project engineer, and Commissioning Authority.

- C. 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 print out of all schedules and set points after testing and acceptance of the system.
 - 5. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - 6. Control equipment component submittals, parts lists, etc.
 - 7. Warranty requirements.
 - 8. 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).
- D. Project Record Documents: See Section 01 78 00 for additional requirements.
 - 1. Submit updated version of control system documentation, for inclusion with operation and maintenance data.
 - 2. Show actual locations of all static and differential pressure sensors (air, water and building pressure) and air-flow stations on project record drawings.

PART 2 PRODUCTS

2.1 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.
- C. Provide the use of Testing and Balancing instruments used by sub-contractors, for consistency of measurements and calibration.

PART 3 EXECUTION

3.1 PREPARATION

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

- B. Furnish additional information requested by the construction manager, project engineer, and Commissioning Authority.
- C. Put all HVAC equipment and systems into operation and continue operation during each working day of testing, adjusting, and balancing and commissioning, as required.
 - 1. Include cost of sheaves and belts that may be required for testing, adjusting, and balancing.
- D. Provide test holes in ducts and plenums where directed to allow air measurements and air balancing; close with an approved plug.
- E. Provide temperature and pressure taps in accordance with Contract Documents.
 - 1. Provide a pressure/temperature plug at each new water sensor that is an input point to the control system.

3.2 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 for each item of equipment or other assembly to be commissioned.
- C. Provide two-way radios for use during the testing.
- D. Test all functions that are described in the sequence of operations.
- E. 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.
 - 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.
 - 8. Closure for Cooling Coil Valves - Normally Closed:
 - a. Set cooling setpoint 20 degrees F above room temperature.
 - b. Observe the valve close.
 - 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 cooling setpoint to 20 degrees F below room temperature.
 - f. Observe valve open.
 - g. Restore to normal.
- F. Isolation Valve or System Valve Leak Check: For valves not by coils.
 - 1. With full pressure in the system, command valve closed.
 - 2. Use an ultra-sonic flow meter to detect flow or leakage.
- G. Deficiencies: Correct deficiencies and re-inspect or re-test, as applicable, at no extra cost to Owner.

3.3 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. 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.

3.4 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.
- 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 Owner, project engineer, and 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 Owner, project engineer, and Commissioning Authority:
 - 1. That all specified functions and features are set up, debugged and fully operable.
 - 2. That scheduling features are fully functional and setup, including holidays.
 - 3. That all graphic screens and value readouts are completed.
 - 4. Correct date and time setting in central computer.
 - 5. That field panels read the same time as the central computer; sample 10 percent of field panels; if any of those fail, sample another 10 percent; if any of those fail test all remaining units at no extra cost to Owner.
 - 6. Power failure and battery backup and power-up restart functions.
 - 7. Global commands features.
 - 8. O&M schedules and alarms.
 - 9. Occupancy sensors and controls.
 - 10. 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.

3.5 OPERATION AND MAINTENANCE MANUALS

- A. See Section 01 78 00 for additional requirements.
- B. Add design intent documentation furnished by Architect to manuals prior to submission to Owner.
- C. Submit manuals related to items that were commissioned to project engineer and Commissioning Authority for review; make changes recommended by project engineer and the Commissioning Authority.

3.6 PRELIMINARY COMMISSIONING REPORT

- A. The preliminary commissioning report shall include the following:
 - 1. Itemization of deficiencies found during the testing required by this section that have not been corrected at the time of report preparation.
 - 2. Deferred tests that cannot be performed at the time of report preparation because of climatic conditions.
 - 3. Climatic conditions required for performance of the deferred tests.
 - 4. Results of functional performance tests.
 - 5. Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance.

3.7 FINAL COMMISSIONING REPORT

- A. See Section 01 78 00 for additional requirements
- B. The final commissioning report shall include the following:
 - 1. Results of functional performance tests.
 - 2. Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
 - 3. Functional performance test procedures used during the commissioning process including measurable criteria for test acceptance, provided herein for repetability.
- C. The final report shall be submitted to the engineer as a submittal for approval, and will serve as the final indication that all work has been executed in accordance with the design.
- D. The final report and any other documentation listed above shall be turned over to the building Owner or Owner's authorized agent within 90 days of the the date of receipt of the certificate of occupancy.

END OF SECTION

SECTION 23 09 23
DIRECT DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK:

- A. This project is an extension of the existing Schneider Electric EcoStruxure for building operation system. See Section 2.1 Acceptable manufacturers.
- B. In accordance to the scope of work, the system shall also provide a graphical, web-based, operator interface that allows for instant access to any system through a standard browser. The contractor must provide PC-based programming workstations, operator workstations and microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions. For this project, the system shall consist of the following components:
- C. Administration and Programming Workstation(s): The BAS Contractor shall include Operation software and architecture as described in Part 2 of the specification. These workstations must be running the standard workstation software developed and tested by the manufacturer of the network server controllers and the standalone controllers. No third-party front-end workstation software will be acceptable. Workstations must conform to the B-OWS BACnet device profile.
- D. Web-Based Operator Workstations: The BAS Contractor shall furnish licenses for web connection to the BAS system. Web-based users shall have access to all system points and graphics, shall be able to receive and acknowledge alarms, and shall be able to control setpoints and other parameters. All engineering work, such as trends, reports, graphics, etc. that are accomplished from the WorkStation shall be available for viewing through the web browser interface without additional changes. The web-based interface must conform to the B-OWS BACnet device profile. There will be no need for any additional computer-based hardware to support the web-based user interface.
- E. Ethernet-based Network Router and/or Network Server Controller(s): The BAS Contractor shall furnish needed quantity of Ethernet-based Network Server Controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet at a minimum of 100mbps and provide communication to the Standalone Digital Control Units and/or other Input/Output Modules. Network Server Controllers shall conform to BACnet device profile B-BC. Network controllers that utilize RS232 serial communications or ARCNET to communicate with the workstations will not be accepted. Network Controllers shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Building Controllers (B-BC).
- F. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment. Each BACnet protocol SDCU shall conform to the BACnet device profile B-AAC. BACnet SDCUs shall be tested and certified by the BACnet Testing Laboratory (BTL) as BACnet Advanced Application Controllers (B-AAC).
- G. The Local Area Network (LAN) shall be either a 10 or 100 Mbps Ethernet network supporting BACnet, Modbus, XML and HTTP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Server Controllers (NSCs), user workstations and a local host computer system.
- H. The Enterprise Ethernet (IEEE 802.3) LAN shall utilize Carrier Sense Multiple/Access/Collision Detect (CSMA/CD), Address Resolution Protocol (ARP) and User Datagram Protocol (UDP) operating at 10 or 100 Mbps.

- I. The system shall enable an open architecture that utilizes ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. Native support for the ANSI / ASHRAE™ Standard 135-2004 BACnet protocol are required to assure that the project is fully supported to reduce future building maintenance, upgrade, and expansion costs.
- J. The system shall enable an architecture that utilizes a MS/TP selectable 9.6-76.8 Kbaud protocol, as a common communication protocol between controllers and integral ANSI / ASHRAE™ Standard 135-2004, BACnet functionality to assure interoperability between all system components. The AAC shall be capable of communicating as a MS/TP device or as a BACnet IP device communicating at 10/100 Mbps on a TCP/IP trunk. The ANSI / ASHRAE™ Standard 135-2004, BACnet protocol is required to assure that the project is fully supported by the leading HVAC open protocol to reduce future building maintenance, upgrade, and expansion costs.
- K. The software tools required for network management of the ANSI / ASHRAE™ Standard 135-2004, BACnet protocol must be provided with the system. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans and are required to meet the functional intent, shall be provided without additional cost to the Owner. BACnet clients shall comply with the BACnet Operator Workstation (B-OWS) device profile; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet IP or MS/TP. The system shall provide support for Modbus TCP and RTU protocols natively, and not require the use of gateways.
- L. Complete temperature control system to be DDC with electronic sensors and electronic/electric actuation of Mechanical Equipment Room (MER) valves and dampers and electronic actuation of terminal equipment valves and actuators as specified herein. The BMS is intended to seamlessly connect devices throughout the building regardless of subsystem type, i.e. variable frequency drives, low voltage lighting systems, electrical circuit breakers, power metering and card access should easily coexist on the same network channel.
- M. The supplied system must incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs. The system shall not require JAVA to be enabled in the browser.
- N. Data shall reside on a supplier-installed server for all database access.
- O. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network.
- P. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the approved manufacturer's local field office. The approved manufacturer's local field office shall have a minimum of 3 years of installation experience with the manufacturer and shall provide documentation in the bid and submittal package verifying longevity of the installing company's relationship with the manufacturer when requested. Supervision, hardware and software engineering, calibration and checkout of the system shall be by the employees of the approved manufacturer's local field office and shall not be subcontracted. The control contractor shall have an in place support facility within 100 miles of the site with factory certified technicians and engineers, spare parts inventory and all necessary test and diagnostic equipment for the installed system, and the control contractor shall have 24 hours/day, 7 days/week emergency service available.
- Q. Provide the Commissioning, configuration and diagnostic tool (CCDT), color display personnel computer, software, and interfaces to provide uploading/downloading of High Point Count Controllers (AAC), Unitary Equipment Controllers (UEC) and VAV controllers (VAVDDC), monitoring all BACnet objects, monitoring overrides of all controller physical input/output points, and editing of controller resident time schedules.

- R. The system shall have the capability to provide a web-enabled PEMS (power and energy management system) monitoring system intended to monitor an entire electrical distribution infrastructure, from incoming utility feeds down to low voltage distribution points. It shall be designed to monitor and manage energy consumption throughout an enterprise, whether within a single facility or across a network of facilities, to improve energy availability and reliability, and to measure and manage energy efficiency. It shall be a standard product offering with no custom programming required. It shall provide a seamless user experience (“Single pane of glass”) for managing the mechanical systems (HVAC and lighting) and monitoring the power distribution system (transformers, breakers, relays, switches, capacitors, UPS, invertors, etc.) Pricing is to be a separate line item from the BAS proposal.

1.2 STANDARD TERMS

A. Standard HVAC Terms:

1. ASHRAE: American Society Heating, Refrigeration, Air Conditioning Engineers
2. AHU: Air Handling Unit
3. BACnet: Building Automation Controls Network
4. BMS: Building Management System
5. DDC: Direct Digital Control
6. EIA: Electronic Industries Alliance
7. GUI: Graphical User Interface
8. HVAC: Heating, Ventilation, and Air Conditioning
9. IEEE: Institute Electrical Electronic Engineers
10. MER: Mechanical Equipment Room
11. PID: Proportional, Integral, Derivative
12. VAV: Variable Air Volume Box

B. Communications and protocols:

1. ARP: Address Resolution Protocol
2. BACnet: Building Automation and Control Networks
3. CORBA: Common Object Request Broker Architecture
4. CSMA/CD: Carrier Sense Multiple Access/Collision Detect
5. DDE: Dynamic Data Exchange
6. FTP: File Transfer Protocol
7. FTT: Free Topology Transceivers
8. HTTP: Hyper Text Transfer Protocol
9. IIOP: Internet Inter-ORB Protocol
10. IP: Internet Protocol
11. LAN: Local Area Network
12. LON: Echelon Communication – Local Operating Network
13. MS/TP: Master Slave Token Passing
14. OBIX: Open Building Information Exchange
15. ODBC: Open Database Connectivity
16. ORB: Object Request Broker
17. SNVT: Standard Network Variables Types
18. SQL: Structured Query Language
19. UDP: User Datagram Protocol
20. XML: eXtensible Markup Language

C. Controllers:

1. ASD: Application Specific Device
2. AAC: Advanced Application Controller
3. ASC: Application Specific Controller.
4. CAC: Custom Application Controller.
5. DCU: Distributed Control Unit
6. LCM: Local Control Module
7. MC: MicroControllers
8. MP: Multi-purpose

9. MPC: Multi-purpose Controller
10. MPV: Multi-purpose VAV controller
11. NSC: Network Server Controller
12. PEM: Package Equipment Module
13. PPC: Programmable Process Controller
14. RC: Room controller
15. SDCU: Standalone Digital Control Units
16. SLC: Supervisory Logic Controller
17. UEC: Unitary Equipment Controller
18. VAVDDC: Variable Air Volume Direct Digital Controller

D. Tools and Software:

1. AFDD: Automated Fault Detection and Diagnostic
2. APEO: Automated Predictive Energy Optimization
3. DR: Demand Response
4. CCDT: Configuration, Commissioning and Diagnostic Tool
5. BPES: BACnet Portable Engineering Station
6. LPES: LON Portable Engineering Station
7. POT: Portable Operator's Terminal
8. PEMS: Power and Energy Management Software

1.3 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all Airflow Stations, Control Dampers, Control Valves, Flow Meters, Flow Switches, Sensor Wells and other similar equipment for installation by the Mechanical Contractor and/or others.
- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 1. Automatic control dampers
 2. The Electrical Contractor shall provide:
 - a. All 120VAC power wiring to motors, heat trace, junction boxes for power to BAS panels.
 - b. Furnish smoke detectors and wire to the building fire alarm system. HVAC Contractor to mount devices.

1.4 CODE COMPLIANCE

- A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.
- B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.
- C. All wiring shall conform to the National Electrical Code.
- D. All smoke dampers shall be rated in accordance with UL 555S.
- E. Comply with FCC rules, Part 15 regarding Class A radiation for computing devices and low power communication equipment operating in commercial environments.
- F. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.5 QUALITY ASSURANCE

- A. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by Day Automation Systems. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.
- B. The Building Management System (BMS) Contractor must have been in business for not less than 10 years and providing BMS systems must be the Contractors primary business. BMS Contractor must be an authorized distributor or branch office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.
- C. The BMS Contractor shall have a training facility with regularly scheduled training so as to provide ongoing regularly scheduled application training.
- D. Electrical standards: Provide electrical products that comply with the following agency approvals:
 - 1. UL-916; Energy Management Systems for BAS components and ancillary equipment
 - 2. UL-873; Temperature Indication and Regulating Equipment
 - 3. FCC, Part 15, Subpart J, Class A Computing Devices
- E. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

1.6 SCOPE OF WORK

- A. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
- B. Provide Schneider Electric EcoStruxure for building operation Front End Software Workstation for this project. All building systems graphics, scheduling and centralized alarming must be developed on this software to provide the campus one portal for the complete system from any existing EcoStruxure for building operation workstation.
- C. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize themselves with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
- D. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor shall review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.
 - 1. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
- E. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process.

1.7 TRAINING

- A. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel.
- B. The BAS Contractor shall have a dedicated training center with a minimum of 8 permanent workstations connected to a simulated system.
- C. Trainees must have the ability to access their system remotely during the classroom training session as required.
- D. The BAS Contractor's trainer must have a minimum of 10 years of experience with the manufacturer's software and products per the following description:
 - 1. On-site training shall consist of a minimum of (8) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
 - a. System Overview
 - b. System Software and Operation
 - 1) System access
 - 2) Software features overview
 - 3) Changing setpoints and other attributes
 - 4) Scheduling
 - 5) Editing programmed variables
 - 6) Displaying color graphics
 - 7) Running reports
 - 8) Workstation maintenance
 - 9) Application programming
 - c. Operational sequences including start-up, shutdown, adjusting and balancing.
 - d. Equipment maintenance
- E. Classroom training shall include a minimum of (6) training slots for two days of course material covering workstation operation and controller programming.
- F. The training facility shall have the capability to provide hands on training experience for all applications that can be run on the Schneider Electric EcoStruxure application.
- G. The training facility shall have the capability to train on the owners' system through off site connection.

1.8 WORK BY OTHERS

- A. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
- B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.
- C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - 1. Automatic Control Dampers
 - 2. Automatic Control Valves.
 - 3. Temperature Sensing Thermal Wells
 - 4. Pressure Control Sensing Taps

1.9 COORDINATION

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment from other divisions including "Intrusion Detection," "Lighting Controls," "Motor Control Centers," "Panel boards," and "Fire Alarm" to achieve compatibility with equipment that interfaces with those systems.

- C. Coordinate supply of conditioned electrical circuits for control units and operator workstation.
- D. Coordinate with the Owner's IT department on locations for NSC's, Ethernet communication cabling and TCP/IP addresses.

1.10 WARRANTY AND ACCEPTANCE

- A. The microprocessor temperature control contractor shall warrant the control system installed in this contract to be free from defects in material and workmanship, except for damages from other causes, for a period of one year after final acceptance from the owner. The microprocessor temperature control contractor shall be responsible for all necessary revisions to the software required for a workable system performance through the first year of operation. Any changes in the software shall be transmitted immediately to the owner. The software responsibility is for a complete and workable system as described in the control cycle description of the specification. The software shall become the property of the owner.
- B. Updates to the manufacturer's software shall be provided at no charge during the warranty period.
- C. All equipment required to maintain operation of the temperature control system for the project shall be stocked in the microprocessor temperature control contractor's local facility. It shall be immediately available in the event of component failure. A spare or loaner piece of equipment shall be installed immediately when a failure occurs, and the equipment shall be returned to the factory for repair.
- D. Submit a proposal to provide all services, materials and the equipment necessary for preventative maintenance on the entire system for a period of one year. The work covered in this proposal shall include maintenance of the control equipment including all computer equipment, CPU, peripherals, transmission equipment, and related HVAC control devices.

1.11 SUBMITTALS

- A. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
 - 1. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.
- B. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
- C. Submit a digital copy of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
- D. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
- E. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
- F. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.

- G. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

1.12 OPERATING AND MAINTENANCE MANUALS

- A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.
- B. Following project completion and testing, the BAS contractor shall submit as-built drawings reflecting the exact installation of the system.

1.13 OWNERSHIP

- A. The Owner shall retain licenses to software for this project.
- B. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition off this contractor. Such license shall grant use of all programs and application software to the Owner as defined by the manufacturer's license agreement but shall protect the manufacturer's rights to disclosure of Trade Secrets contained within such software.
- C. The licensing agreement shall not preclude the use of the software by individuals under contract to the owner for commissioning, servicing or altering the system in the future. Use of the software by individuals under contract to the owner shall be restricted to use on the owner's computers and only for the purpose of commissioning, servicing, or altering the installed system.
- D. All project developed software, files and documentation shall become the property of the Owner. These include but are not limited to:
 - 1. Server and workstation software
 - 2. Application programming tools
 - 3. Configuration tools
 - 4. Network diagnostic tools
 - 5. Addressing tools
 - 6. Application files
 - 7. Configuration files
 - 8. Graphic files
 - 9. Report files
 - 10. Graphic symbol libraries
 - 11. All documentation

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturer - Provide the following microprocessor control system:
 - 1. Basis of Design: Schneider Electric EcoStruxure, provided and installed by Day Automation systems.
 - 2. No substitutions are acceptable.

2.2 SYSTEM ARCHITCTURE

- A. General

1. The Building Automation System (BAS) shall consist of Network Server/Controllers (NSCs), a family of Standalone Digital Control Units (SDCUs), Administration and Programming Workstations (APWs), and Web-based Operator Workstations (WOWs). The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable.
 2. An Enterprise Level BAS shall consist of an Enterprise Server, which enables multiple NSCs (including all graphics, alarms, schedules, trends, programming, and configuration) to be accessible from a single Workstation simultaneously for operations and engineering tasks.
 3. The Enterprise Level BAS shall be able to host up to 250 servers, or NSCs, beneath it.
 4. For Enterprise reporting capability and robust reporting capability outside of the trend chart and listing ability of the Workstation, a Reports Server shall be installed on a Microsoft Windows SQL based computer. The Reports Server can be installed on the same computer as the Enterprise Server.
 5. The system shall be designed with a top-level 10/100bT Ethernet network, using the BACnet/IP and/or Modbus TCP protocol.
- B. Modbus RTU/ASCII (and J-bus), Modbus TCP, BACnet MS/TP, BACnet IP and WebServices shall be native to the NSCs. There shall not be a need to provide multiple NSCs to support all the network protocols, nor should there be a need to supply additional software to allow all three protocols to be natively supported.
- C. A sub-network of SDCUs using the BACnet IP protocol shall connect the local, stand-alone controllers with Ethernet-level Network Server Controllers/IP Routers.
- D. TCP/IP Level
1. The TCP/IP layer connects all of the buildings on a single Wide Area Network (WAN) isolated behind the campus firewall. Fixed IP addresses for connections to the campus WAN shall be used for each device that connects to the WAN.
- E. Fieldbus Level with Standalone Digital Control Units (SDCUs)
1. The fieldbus layer shall support all of the following types of SDCUs:
 - a. BACnet IP SDCU requirements: The system shall consist of one or more BACnet/IP field buses managed by the Network Server Controller. The field bus layer shall consist of up to 50 IP SDCUs in daisy chain topology, or 36 if using RSTP, per layer, with a max of 5 sub networks in daisy chain for a total of 250 SDCUs or 6 sub networks in RSTP for a total of 234 SDCUs. The field bus layer shall consist ONLY of BACnet IP SDCUs. No other protocols, including BACnet MS/TP, shall be acceptable.
- F. BAS LAN Segmentation
1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN). Workstations can manage a single LAN (or building), and/or the entire system with all portions of that LAN maintaining its own, current database.
- G. Standard Network Support
1. All NSCs, Workstation(s) and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NSC's, Workstation(s), and Server(s) shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Systems Department as all devices utilize standard TCP/IP components.
- H. System Expansion
1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same TCP/IP level and fieldbus level controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
 2. Web-based operation shall be supported directly by the NSCs and require no additional software.

3. The system shall be capable of using graphical and/or line application programming language for the Network Server Controllers.
- I. Support For Open Systems Protocols
 1. All Network Server Controllers must natively support the BACnet IP, BACnet MS/TP, Modbus TCP, Modbus RTU (RS-485 and RS-232), and Modbus ASCII protocols.

2.3 OPERATOR WORKSTATION REQUIREMENTS

- A. General
 1. The operator workstation portion of the BAS shall consist of one or more full-powered configuration and programming workstations, and one or more web-based operator workstations. For this site provide a minimum 4 concurrent engineering users within the enterprise server.
 2. The programming and configuration workstation software shall allow any user with adequate permission to create and/or modify any or all parts of the NSC and/or Enterprise Server database.
 3. Web-based workstations (webstations) shall have a minimum of 20 concurrent operator users.
 4. All configuration workstations shall be personal computers operating under the Microsoft Windows operating system. The application software shall be capable of communication to all Network Server Controllers and shall feature high-resolution color graphics, alarming, trend charting. It shall be user configurable for all data collection and data presentation functions.
 5. A minimum of 1 physical Workstations shall be allowed on the Ethernet network. In this client/server configuration, any changes or additions made from one workstation will automatically appear on all other workstations since the changes are accomplished to the databases within the NSC. Systems with a central database will not be acceptable.
- B. Administration/Programming Workstation, Enterprise Server, and Enterprise Central Requirements:
 1. The Enterprise Central shall consist of the following:
 - a. Processor
 - 1) Minimum: Intel Xeon E5-2407 2.20 GHz, 10M Cache
 - b. Memory
 - 1) Minimum: 16GB
 - c. Operating systems:
 - 1) Microsoft Windows 8.1 32-bit (Pro, Pro N, Enterprise, or Enterprise N)
 - 2) Microsoft Windows 8.1 64-bit (Pro, Pro N, Enterprise, or Enterprise N)
 - 3) Microsoft Windows 10 64-bit (Pro or Enterprise)
 - 4) Microsoft Windows Server 2012 64-bit (Standard, Datacenter, Essentials, or Foundation)
 - 5) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
 - 6) Microsoft Windows Server 2016 R2 64-bit (Standard, Datacenter, Essentials, or Foundation)
 - d. 10/100MBPS Ethernet NIC
 - e. 2-1Tb 7200 RPM SATA 3 RAID 1 Drive
 - f. Required additional software:
 - 1) Microsoft .Net 4.5
 - g. License agreement for all applicable software
 2. The workstation shall consist of the following:
 - a. Processor
 - 1) Intel Core i3-7500 3.4GHz
 - b. Memory
 - 1) 8 GB RAM, 1TB HDD
 - c. Operating systems:
 - 1) Microsoft Windows 10 64-bit (Pro or Enterprise)
 - d. Serial port, parallel port, USB port
 - e. 10/100MBPS Ethernet NIC
 - f. 1 TB HDD
 - g. DVD drive
 - h. High resolution (minimum 1920 x 1080), 22" flat panel display

- i. Optical mouse and full function keyboard
 - j. Audio sound card and speakers
 - k. UPS Back-Up
 - l. License agreement for all applicable software.
- C. Web-Based Operator PC Requirements
 - 1. Any user on the network can access the system, using the following software:
 - a. Internet Explorer 11
 - b. Mozilla Firefox
 - c. Google Chrome
- D. General Administration and Programming Workstation Software:
 - 1. System architecture shall be truly client server in that the Workstation shall operate as the client while the NSCs shall operate as the servers. The client is responsible for the data presentation and validation of inputs while the server is responsible for data gathering and delivery.
 - 2. The workstation functions shall include monitoring and programming of all DDC controllers. Monitoring consists of alarming, reporting, graphic displays, long term data storage, automatic data collection, and operator-initiated control actions such as schedule and setpoint adjustments.
 - 3. Programming of SDCUs shall be capable of being done either off-line or on-line from any operator workstation. All information will be available in graphic or text displays stored at the NSC. Graphic displays will feature animation effects to enhance the presentation of the data, to alert operators of problems, and to facilitate location of information throughout the DDC system. All operator functions shall be selectable through a mouse.
- E. User Interface:
 - 1. The BAS workstation software shall allow the creation of a custom, browser-style interface linked to the user when logging into any workstation. Additionally, it shall be possible to create customized workspaces that can be assigned to user groups. This interface shall support the creation of "hot-spots" that the user may link to view/edit any object in the system or run any object editor or configuration tool contained in the software. Furthermore, this interface must be able to be configured to become a user's "PC Desktop" – with all the links that a user needs to run other applications. This, along with the Windows user security capabilities, will enable a system administrator to setup workstation accounts that not only limit the capabilities of the user within the BAS software, but may also limit what a user can do on the PC and/or LAN/WAN. This might be used to ensure, for example, that the user of an alarm monitoring workstation is unable to shutdown the active alarm viewer and/or unable to load software onto the PC.
 - 2. System shall be able to automatically switch between displayed metric vs. imperial units based on the workstation/webstations localization.
 - 3. The BMS workstation/webstations shall be capable of multiple language display, including English, Spanish, German, French, Japanese, Italian, Finnish, Portuguese, Swedish, Russian, and traditional and simplified Chinese. The multiple languages shall not require additional add on software from the standard workstation installer and shall be selectable within said workstation.
 - 4. Webstations shall have the capability to automatically re-direct to an HTTPS connection to ensure more secure communications.
 - 5. Personalized layouts and panels within workstations shall be extended to webstations to ensure consistent user experiences between the two user interfaces.
 - 6. Servers and clients shall have the ability to be located in different time zones, which are then synchronized via the NTP server.
 - 7. Workstation shall indicate at all times the communication status between it and the server.
- F. User Security:
 - 1. The software shall be designed so that each user of the software can have a unique username and password. The system must allow a minimum of 256 users to be configured per workstation. Additionally, the software shall enable the ability to add/remove users based upon Microsoft Windows Security Domains that enable the customer IT department to assist in user access.
 - 2. Additional requirements include mandatory change of passwords:
 - a. At first logon with default credentials.
 - b. Of admin passwords before deploying.

3. No general accounts, one account per user.
4. Capability to integrate and use Windows Active Directory for user log on credentials.
5. Include a timed auto log off feature.
6. Use TLS 1.2 encryption or higher.
7. Capability to use blacklisted and whitelisted IPs/MAC addresses to gate access.
8. All devices and software that support HTTP shall allow disabling the HTTP access and require access via HTTPS.
9. All devices that have web portals for the configuration of IP addresses and other configuration attributes shall have the ability, through commands issued, to disable this service upon completion. A direct connection method with ASCII commands shall enable this service again if changes need to be applied. Loss of power or cycling the device shall not reverse this command. Disabling this web portal eliminates the security risk and the need for updating security patches.
10. All devices shall support SNMP V3 monitoring of network performance and stack statistics for the purpose of managing denial of service attacks
11. The Integrated Control Platform shall support the feature to alarm on a predetermined period of time until the default password for each device is changed from the default factory setting.
12. The Integrated Control Platform shall support encrypted password authentication for all web services whether serving or consuming.

G. Configuration Interface

1. The workstation software shall use a familiar Windows Explorer style interface for an operator or programmer to view and/or edit any object (controller, point, alarm, report, schedule, etc.) in the entire system. In addition, this interface shall present a “network map” of all controllers and their associated points, programs, graphics, alarms, and reports in an easy to understand structure. All object names shall be alphanumeric and use Windows long filename conventions.
2. The configuration interface shall also include support for user defined object types. These object types shall be used as building blocks for the creation of the BAS database. They shall be created from the base object types within the system input, output, string variables, setpoints, etc., alarm algorithms, alarm notification objects, reports, graphics displays, schedules, and programs. Groups of user defined object types shall be able to be set up as a predefined aggregate of subsystems and systems. The configuration interface shall support copying/pasting and exporting/importing portions of the database for additional efficiency. The system shall also maintain a link to all “child” objects created. If a user wishes to make a change to a parent object, the software shall ask the user if he/she wants to update all of the child objects with the change.

H. Color Graphic Displays

1. The system shall allow for the creation of user defined, color graphic displays for the viewing of mechanical and electrical systems, or building schematics. These graphics shall contain point information from the database including any attributes associated with the point (engineering units, etc.). In addition operators shall be able to command equipment or change setpoints from a graphic through the use of the mouse.
2. Requirements of the color graphic subsystem include:
 - a. At a minimum, the user shall have the ability to import .gif, .png, .bmp, .jpeg, .tif, and CAD generated picture files as background displays, and layering shall be possible.
 - b. The system shall support HTML5 enabled graphics.
 - c. It shall be possible for the user to use JavaScript to customize the behavior of each graphic.
 - d. The editor shall use Scalable Vector Graphics (SVG) technology.
 - e. A built-in library of animated objects such as dampers, fans, pumps, buttons, knobs, gauges, and graphs which can be “dropped” on a graphic through the use of a software configuration “wizard”. These objects shall enable operators to interact with the graphic displays in a manner that mimics their mechanical equivalents found on field installed control panels.
 - f. Support for high DPI icons shall be included and automatically chosen if viewing on a high definition display such as Retina or 4K displays.
 - g. Using the mouse, operators shall be able to adjust setpoints, start or stop equipment, modify PID loop parameters, or change schedules.
 - h. Status changes or alarm conditions must be able to be highlighted by objects changing screen location, size, color, text, blinking or changing from one display to another.

- i. Ability to link graphic displays through user defined objects, alarm testing, or the result of a mathematical expression. Operators must be able to change from one graphic to another by selecting an object with a mouse - no menus will be required.
 - j. It shall be possible to create and save graphical components and JavaScript code in reusable and transferrable, customized libraries.
 - k. Graphics should rescale based on whatever monitor or viewing device is being used.
 - l. Be able to create graphics on varying layers that can be moved and repeated.
 - m. Be able to create graphics within varying window panes that can be moved and/or re-referenced. For example, creating the graphical menu within a pane and referencing it on every graphics page, therefore not rebuilding thus allowing for a single spot for updates that get pushed to all the pages that reference it.
 - n. The ability to create re-usable cascading menus.
 - o. The ability to have multiple instances of a graphic and edit one instance to change all.
- 3. Additionally, the Graphics Editor portion of the Engineering Software shall provide the following capabilities:
 - a. Create and save pages.
 - b. Group and ungroup symbols.
 - c. Modify an existing symbol.
 - d. Modify an existing graphic page.
 - e. Rotate and mirror a symbol.
 - f. Place a symbol on a page.
 - g. Place analog dynamic data in decimal format on a page.
 - h. Place binary dynamic data using state descriptors on a page.
 - i. Create motion through the use of animated .gif files or JavaScript.
 - j. Place test mode indication on a page.
 - k. Place manual mode indication on a page.
 - l. Place links using a fixed symbol or flyover on a page.
 - m. Links to other graphics.
 - n. Links to web sites.
 - o. Links to notes.
 - p. Links to time schedules.
 - q. Links to any .exe file on the operator work station.
 - r. Links to .doc files.
 - s. Assign a background color.
 - t. Assign a foreground color.
 - u. Place alarm indicators on a page.
 - v. Change symbol/text/value color as a function of an analog variable.
 - w. Change a symbol/text/value color as a function of a binary state.
 - x. Change symbol/text/value as a function of a binary state.
 - y. All symbols used by Schneider Electric EcoBuilding Business in the creation of graphic pages shall be saved to a library file for use by the owner.
- I. Automatic monitoring
 - 1. The software shall allow for the automatic collection of data and reporting from any controller or NSC. The frequency of data collection shall be user-configurable.
- J. Alarm Management
 - 1. The software shall be capable of accepting alarms directly from NSCs or controllers, or generating alarms based on evaluation of data in controllers and comparing to limits or conditional equations configured through the software. Any alarm (regardless of its origination) will be integrated into the overall alarm management system and will appear in all standard alarm reports, be available for operator acknowledgment, and have the option for displaying graphics, or reports.
 - 2. Alarm management features shall include:
 - a. A minimum of 1000 alarm notification levels at the NSC, workstation, and webstation levels. At the Enterprise level the minimum number of active and viewable alarms shall be 10,000. Each notification level will establish a unique set of parameters for controlling alarm display, distribution, acknowledgment, keyboard annunciation, and record keeping.

- b. Automatic logging in the database of the alarm message, point name, point value, source device, timestamp of alarm, username and time of acknowledgement, username and time of alarm silence (soft acknowledgement).
 - c. Playing an audible sound on alarm initiation or return to normal.
 - d. Sending an email page to anyone specifically listed on the initial occurrence of an alarm. The ability to utilize email paging of alarms shall be a standard feature of the software using Simple Mail Transfer Protocol (SMTP) with support for secure email using Simple Mail Transfer Protocol Secure (SMTPS) No special software interfaces shall be required and no email client software must be running in order for email to be distributed. The email notification shall be able to be sent to an individual user or a user group.
 - e. Individual alarms shall be able to be re-routed to a user at user-specified times and dates. For example, a critical high temp alarm can be configured to be routed to a Facilities Dept. workstation during normal working hours (7am-6pm, Mon-Fri) and to a Central Alarming workstation at all other times.
 - f. An active alarm viewer shall be included which can be customized for each user or user type to hide or display any alarm attributes.
 - g. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of user actions for certain alarms.
 - h. The active alarm viewer can be configured such that an operator must type in text in an alarm entry and/or pick from a drop-down list of causes for certain alarms. This ensures accountability (audit trail) for the response to critical alarms.
 - i. The active alarm viewer can be configured such that an operator must confirm that all of the steps in a check list have been accomplished prior to acknowledging the alarm.
 - j. The active alarm viewer shall, if filtered, show the quantity of visible and total number of alarms that are not equal to 'normal' and the quantity of disabled and hidden alarms.
 - k. The alarm viewer can be configured to auto hide alarms when triggered.
 - l. An operator shall have the capability to assign an alarm to another user of the system.
 - m. Time schedules shall be able to be used to set control notifications to users.
 - n. An operator shall have the capability to save and apply alarm favorites.
 - o. Alarm notifications must support multiple distribution methods within one notification.
- K. Report Generation
- 1. The Reports Server shall be able to process large amounts of data and produce meaningful reports to facilitate analysis and optimization of each installation.
 - 2. Reports shall be possible to generate and view from the operator Workstation, and/or Webstation, and/or directly from a reports-only web interface.
 - 3. A library of predefined automatically generated reports that prompt users for input prior to generation shall be available. The properties and configurations made to these reports shall be possible to save as Dashboard reports, so that the configurations are saved for future used.
 - 4. It shall be possible to create reports standard tools, such as Microsoft Report Builder 2.0 or Visual Studio, shall be used for customized reports.
 - 5. Additional reports or sets of reports shall be downloadable, transferrable, and importable
 - 6. All reports shall be able to be set up to automatically run or be generated on demand.
 - 7. Each report shall be capable of being automatically emailed to a recipient in Microsoft Word, Excel, and/or Adobe .pdf format.
 - 8. Reports can be of any length and contain any point attributes from any controller on the network.
 - 9. Image management functionality shall be possible to enable the system administrators to easily upload new logos or images to the system.
 - 10. It shall be possible to run other executable programs whenever a report is initiated.
 - 11. Report Generator activity can be tied to the alarm management system, so that any of the configured reports can be displayed in response to an alarm condition.
 - 12. Minimum supplied reports shall include:
 - a. Activities Per Server Report
 - b. Activities Per User Report
 - c. Alarm Amount by Category Report
 - d. Alarm Amount by Type Report
 - e. Alarms Per Sever Report

- f. Current Alarm Report
 - g. Most Active Alarm Report
 - h. System Errors Per Server Report
 - i. Top Activities Report
 - j. Top Alarms Report
 - k. Top System Errors Report
 - l. Trend Log Comparison Report
 - m. User Logins Report
 - n. Users and Groups Reports
13. Minimum Energy Reports shall include:
- a. Energy Monitoring Calendar Consumption Report: Shall provide an interactive report that shows the energy usage on one or multiple selected days.
 - b. Energy Monitoring Consumption Breakdown Report: Shall provide a report on energy consumption broken down using sub-metering.
 - c. Energy Monitoring Consumption Report: Shall show the energy consumption against a specified target value.
14. Reports Server Hardware Requirements
- a. Processor
 - 1) Minimum: 2.0 GHz
 - 2) Recommended: 2.0 GHz or higher
 - b. Memory
 - 1) Minimum: 6 GB
 - 2) Recommended: 8GB or higher
 - c. Hard Disk: 500 GB
15. Reports Server Software Requirements
- a. Operating System:
 - 1) Microsoft Windows 8.1 32-bit (Pro or Enterprise)
 - 2) Microsoft Windows 8.1 64-bit (Pro or Enterprise)
 - 3) Microsoft Windows 10 64-bit (Pro or Enterprise)
 - 4) Microsoft Windows Server 2012 64-bit (Standard)
 - 5) Microsoft Windows Server 2012 R2 64-bit (Standard, Datacenter)
 - b. SQL Versions:
 - 1) Microsoft SQL Server 2008 R2 64-bit SP2 (Standard and Express with Advanced Services)
 - 2) Microsoft SQL Server 2012 64-bit (Standard and Express with Advanced Services)
 - c. Additional required software"
 - 1) Microsoft .Net 4.5
- L. Scheduling
- 1. From the workstation or webstation, it shall be possible to configure and download schedules for any of the controllers on the network.
 - 2. Time of day schedules shall be in a calendar style and viewable in both a graphical and tabular view.
 - 3. Schedules shall be programmable for a minimum of one year in advance.
 - 4. To change the schedule for a particular day, a user shall simply select the day and make the desired modifications.
 - 5. Additionally, from the operator webstations, each schedule will appear on the screen viewable as the entire year, monthly, week and day. A simple mouse click shall allow switching between views. It shall also be possible to scroll from one month to the next and view or alter any of the schedule times.
 - 6. Schedules will be assigned to specific controllers and stored in their local RAM memory. Any changes made at the workstation will be automatically updated to the corresponding schedule in the controller.
 - 7. It shall be possible to assign a lead schedule such that shadow/local schedules are updated based upon changes in the Lead.
 - 8. It shall be possible to assign a list(s) of exception event days, dates, date ranges to a schedule.

9. It shall be possible to view combined views showing the calendar and all prioritized exemptions on one screen.
 10. It should accommodate a minimum of 16 priority levels.
 11. Values should be able to be controlled directly from a schedule, without the need for special program logic.
- M. Programmer's Environment
1. Programming in the NSC shall be either in graphical block format or line-programming format or both.
 2. Programming of the NSC shall be available offline from system prior to deployment into the field. All engineering tasks shall be possible, except, of course, the viewing of live tasks or values.
 3. The programmer's environment will include access to a superset of the same programming language supported in the SDCUs.
 4. NSC devices will support both script programming language as well as the graphical function block programming language. For both languages, the programmer will be able to configure application software for custom program development, and write global control programs. Both languages will have debugging capabilities in their editors.
 5. It shall be possible to save custom programs as libraries for reuse throughout the system. A wizard tool shall be available for loading programs from a library file in the program editor.
 6. It shall be possible to view graphical programming live and real-time from the Workstation.
 7. The system shall be capable of creating 'binding templates' allowing the user to bind multiple points to multiple objects all at once.
 8. Key terms should appear when typing (IntelliType).
 9. Applications should be able to be assigned different priorities and cycle times for a prioritized execution of different function.
 10. The system shall be able to create objects that allow common objects such as power meters, VFD drives, etc. to be integrated into the system with simple import actions without the need of complicated programming or configuration setups.
- N. Saving/Reloading
1. The workstation software shall have an application to save and restore NSC and field controller memory files.
 2. For the NSC, this application shall not be limited to saving and reloading an entire controller – it must also be able to save/reload individual objects in the controller. This allows off-line debugging of control programs, for example, and then reloading of just the modified information.
- O. Audit Trail
1. The workstation software shall automatically log and timestamp every operation that a user performs at a workstation, from logging on and off a workstation to changing a point value, modifying a program, enabling/disabling an object, viewing a graphic display, running a report, modifying a schedule, etc.
 2. It shall be possible to view a history of alarms, user actions, and commands for any system object individually or at least the last 5000 records of all events for the entire system from Workstation.
 3. The Enterprise server shall be able to store up to 5 million events.
 4. The event view shall support viewing of up to 100,000 events.
 5. It shall be possible to save custom filtered views of event information that are viewable and configurable in Workstation.
 6. It shall be capable to search and view all forced values within the system.
- P. Fault Tolerant Enterprise Server Operation (Top level NSC)
1. A single component failure in the system shall not cause the entire system to fail. All system users shall be informed of any detectable component failure via an alarm event. System users shall not be logged off as a result of a system failure or switchover.
- Q. Web-based Operator Software
1. General:
 - a. Day-to-day operation of the system shall be accessible through a standard web browser interface, allowing technicians and operators to view any part of the system from anywhere on the network.

- b. The system shall be able to be accessed on site via a mobile device environment with, at a minimum, access to overwrite and view system values.
 - 2. Graphic Displays
 - a. The browser-based interface must share the same graphical displays as the Administration and Programming Workstations, presenting dynamic data on site layouts, floor plans, and equipment graphics. The browser's graphics shall support commands to change setpoints, enable/disable equipment and start/stop equipment.
 - b. Through the browser-based interface, operators must be able to navigate through the entire system, and change the value or status of any point in any controller. Changes are effective immediately to the controller, with a record of the change stored in the system database.
 - 3. Alarm Management
 - a. Systems requiring additional client software to be installed on a PC for viewing the webstation from that PC will not be considered.
 - b. Through the browser interface, a live alarm viewer identical to the alarm viewer on the Administration and Programming workstation shall be presented, if the user's password allows it. Users must be able to receive alarms, silence alarms, and acknowledge alarms through a browser. If desired, specific operator text must be able to be added to the alarm record before acknowledgement, attachments shall be viewable, and alarm checklists shall be available.
- R. Groups and Schedules
 - 1. Through the browser interface, operators must be able to view pre-defined groups of points, with their values updated automatically.
 - 2. Through the browser interface, operators must be able to change schedules – change start and stop times, add new times to a schedule, and modify calendars.
- S. User Accounts and Audit Trail
 - 1. The same user accounts shall be used for the browser interface and for the operator workstations. Operators must not be forced to memorize multiple passwords.
 - 2. All commands and user activity through the browser interface shall be recorded in the system's activity log, which can be later searched and retrieved by user, date, or both.
- T. Web Services
 - 1. The installed system shall be able to use web services to “consume” information within the Network Server/Controllers (NSCs) with other products and systems. Inability to perform web services within the NSCs will be unacceptable.
 - a. Shall be able to “consume” data into the system via SOAP and REST web services.

2.4 BACNET FIELDBUS CONTROLLERS

- A. Controllers – BACnet/IP Protocol
 - 1. All BACnet/IP Fieldbus controllers shall be BACnet Testing Laboratory listed (v12 or later) as specified BACnet Advanced Application Controller (B-AAC)
 - 2. All BACnet/IP Fieldbus controllers shall use the following communication specifications and achieve performance as specified herein:
 - a. All controllers shall be able to communicate peer-to-peer without the need for an NSC.
 - b. Any BACnet/IP Fieldbus controllers on the Ethernet Data Link/Physical layer shall be able to act as a Master to allow for the exchange and sharing of data variables and messages with any other controller connected on the same communication cabling. Slave controllers are not acceptable.
- B. The BACnet/IP Fieldbus controllers shall be equipped with 2x 10/100bT Ethernet communication ports with active switch and will support BACnet/IP communication protocols with the following configurations:
 - 1. Supporting IPv4 addressing.
 - 2. Supporting Static IP setting, DHCP client and Auto-IP address acquisition.
 - 3. It shall be possible to disable Ethernet port 2.
- C. Topologies

1. BACnet/IP Fieldbus Controllers shall support RSTP loop whereby up to 36 controllers are supported.
2. In case of any disruption there shall be no communication interruption.
3. In case of any disruption there shall be system alarms that will inform the operator of the disruption.

D. Performance

1. Each BACnet/IP Fieldbus Controllers shall have a 32-bit microprocessor operating at 500 MHz and support a BACnet protocol stack in accordance with the ANSI/ASHRAE Standard 135-2008 and the BACnet Device Profile supported.
2. They shall be multi-tasking, real-time digital control processors consisting of communication controllers, controls processing, power supplies with built-in inputs and outputs.

E. Programmability

1. The BACnet/IP Fieldbus controllers shall support both script programming language and graphical that will be consistent with the NSC.
2. The control program will reside within the same enclosure as the input/output circuitry, that reads inputs and controls outputs.
3. All control sequences programmed into the BACnet/IP Fieldbus Controllers shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
4. BACnet/IP Fieldbus controllers shall communicate with the Network Server Controller (NSC) via a BACnet/IP connection at a baud rate of not less than 100 Mbps.
5. BACnet/IP Fieldbus controllers shall support a dedicated communications port for connecting and supplying power to a matching room temperature and/or humidity sensor and/or CO2 and/or presence detector that does not utilize any of the I/O points of the controller.
6. BACnet/IP Fieldbus controllers (Excluding VAV) shall support an add-on display to supply and provide access in real-time for monitoring inputs and overriding of outputs.
7. The override functionality must be supported by a dedicated processor to assure reliable operation (overriding of output).
8. Each BACnet/IP Fieldbus controller shall have sufficient memory, to support its own operating system and databases, including:
 - a. Control processes
 - b. Energy management applications
 - c. Alarm management
 - d. Historical/trend data
 - e. Maintenance support applications
 - f. Custom processes
 - g. Manal override monitoring
9. Each BACnet/IP Fieldbus controller shall support local trend data up to 2x the built-in I/O and at a minimum be capable of holding 5 days @ 15 min intervals locally.
10. The BACnet/IP Fieldbus controller analog or universal input shall use a 16 bit A/D converter.
11. The BACnet/IP Fieldbus controller analog or universal output shall use a 10 bit D/A converter.
12. Built-in I/O: each BACnet/IP Fieldbus controllers shall support:
 - a. At minimum 8 and up to 20 configurable IO channels to monitor and to control the following types of inputs and outputs without the addition of equipment inside or outside the DDC Controller cabinet.
 - 1) Universal Inputs – the following thermistors for use in the system without any external converters needed.
 - (a) 10 kohm Type I (Continuum)
 - (b) 10 kohm Type II (I/NET)
 - (c) 10 kohm Type III (Satchwell)
 - (d) 10 kohm Type IV (FD)
 - (e) Linearized 10 kohm Type V (FD w/11k shunt)
 - (f) Linearized 10 kohm (Satchwell)
 - (g) 1.8 kohm (Xenta)
 - (h) 1 kohm (Balco)
 - (i) 20 kohm (Honeywell)
 - (j) 2.2 kohm (Johnson)

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- (k) PT100 (Siemens)
 - (l) PT1000 (Sauter)
 - (m) Ni1000 (Danfoss)
 - b. Analog inputs
 - 1) Current Input - 0-20 mA
 - 2) Voltage Input 0-10 Vdc
 - c. Digital inputs from dry contact closure, pulse accumulators, voltage sensing.
 - d. Digital outputs
 - e. Analog outputs of 4-20 mA and/or 0-10 Vdc
 - 13. Real Time Clock (RTC):
 - a. Each BACnet/IP Fieldbus controller shall include a real time clock, accurate to +/-1 minute per month. The RTC shall provide the following: time of day, day, month, year, and day of week.
 - b. The RTC date and time shall also be accurate, up to 7 days, when the BACnet/IP Fieldbus controller is powerless.
 - c. No batteries may be used to for the backup of the RTC.
 - 14. The BACnet/IP Fieldbus controller for Variable Air Volume (VAV) applications
 - a. The BACnet/IP Fieldbus controller for VAV applications shall include a built-in 'flow thru' differential pressure transducer.
 - b. The VAV differential pressure transducer shall have a measurement range of 0 to 1 in. W.C. and measurement accuracy of $\pm 5\%$ at 0.001 to 1 in. W.C. and a minimum resolution of 0.001 in. W.C., ensuring primary air flow conditions shall be controlled and maintained to within $\pm 5\%$ of setpoint at the specified minimum and maximum air flow parameters.
 - c. The BACnet/IP Fieldbus controller for VAV applications shall support a dedicated commissioning tool for air flow balancing
 - d. The BACnet/IP Fieldbus controller for VAV applications shall require no programming for air balancing algorithm.
 - e. All balancing parameters shall be synchronized in NSC.
 - 15. Each BACnet/IP Fieldbus controller shall have a minimum of 10% spare capacity for each point type represented on the controller for future point connection.
 - 16. Power Requirements.: 24VDC (21 to 33 VDC) and 24 VAC +/-20% with local transformer power.
- F. Commissioning Tool - The BACnet/IP Fieldbus controller shall be supported via a dedicate mobile based commissioning tool for configuration, programming, air balancing and I/O checkout
- 1. The Commissioning Tool shall be supported across: iOS, Android and Windows 10 platforms
 - 2. The Commissioning Tool shall be available for download on App Store, Google Store and Windows Store
 - 3. Commissioning Tool Interface to BACnet/IP Fieldbus controllers shall be via a Bluetooth adapter interface through the Intelligent Space Sensor or via a Wi-Fi access point on the LAN
 - 4. Functionality
 - a. Device Configuration – the Commissioning Tool shall be able to set or edit all Network configurations associated with the BACnet/IP Fieldbus controller
 - b. Programming – The Commissioning Tool shall be able to load offline engineered applications directly into the controller directly
 - c. Air Balancing:
 - 1) The Commissioning Tool shall allow the air balancer to manually control the action of the actuator including the following function: open VAV damper, close VAV damper, open all VAV dampers, and close all VAV dampers.
 - 2) The Commissioning Tool shall be able to generate Air Balancing report
 - d. IO Checkout
 - 1) The Commissioning Tool shall be able to support overriding of the outputs and reading value of inputs live
 - 2) The Commissioning Tool shall be able to support generation of I/O checkout report
 - e. There shall be no limit to the number of Commissioning Tools that can be used on a network segment, however, one connection per controller is recommended

- G. Intelligent Space Sensors - The BACnet/IP Fieldbus controller shall support a dedicated RJ45 communication port to communicate and power up to 4 intelligent wall mount sensors without the use of on-board inputs or outputs
 - 1. The Intelligent Space Sensor shall communicate with the BACnet/IP Fieldbus controller through the sensor port and via category 5 or category 6 cable
 - 2. The Intelligent Space Sensor shall provide 2 RJ45 communication ports that will allow communication with parent BACnet/IP Field controller upstream and additional Intelligent Space Sensors downstream
 - 3. The Intelligent Space Sensor shall provide ambient space condition sensing without the use of hardware I/O
- H. Each Intelligent Space Sensor shall provide a color touch display with:
 - 1. Minimum 61 mm (2.4") by 61 mm (2.4") display
 - 2. Backlit
- I. The Intelligent Space Sensor shall be capable of displaying measured space temperature from 0 to 50 °C (32 to 122 °F) with accuracy of ± 0.2 °C (± 0.4 °F) selectable for 0.1 or 1 degree display resolution of °F or °C
 - 1. Sensing Element: 10k Type 3 Thermistor
 - 2. Accuracy of ± 0.2 °C (± 0.4 °F)
 - 3. Resolution: 0.1 or 1 degree display resolution
 - 4. Range: 0 to 50 °C (32 to 122 °F)
- J. The Intelligent Space Sensor shall have the option for humidity sensor support sensing humidity from 0 % RH to 100 % RH Digital humidity indication (selectable for 0.1 or 1% RH with selectable display resolution of 0.1 or 1 % RH)
 - 1. Accuracy: ± 2 % RH
 - 2. Resolution: 0.1 or 1 % RH
 - 3. Range: 0 % RH to 100 % RH
- K. The Intelligent Space Sensor shall have the option for support of CO2 sensor with display resolution with 0 to 2000 ppm resolution
 - 1. Accuracy: ± 30 ppm $\pm 2\%$ of measured value
 - 2. Range: 0 to 2,000 ppm
 - 3. Operating elevation: 0 to 16,000 ft.
 - 4. Temperature dependence: 0.11% FS per °F
 - 5. Stability: $< 2\%$ of FS over life of sensor (15 years)
 - 6. Sensing method: Non-dispersive infrared (NDIR), diffusion sampling
- L. The Intelligent Space Sensor shall have the option for motion sensor
- M. Display options: The Intelligent Space Sensor shall be capable of displaying the following elements:
 - 1. Space temperature
 - 2. Cooling space temperature set point
 - 3. Heating space temperature set point
 - 4. Current heating or cooling mode
 - 5. Current occupancy mode
 - 6. Fan speed
 - 7. Current time
- N. Commissioning Tool Interface – the Intelligent Space Sensor shall support a Bluetooth adaptor interface to allow connectivity of a commissioning tool.

2.5 DDC SENSORS AND POINT HARDWARE

- A. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:
- B. Temperature Sensors:

1. All temperature devices shall use precision thermistors accurate to $\pm 0.36^{\circ}\text{F}$ over a range of -30 to 230°F .
 2. Standard space sensors shall be provided in an off-white enclosure for mounting on a standard electrical box.
 3. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
 4. Where manual adjustment to the setpoint is indicated on the drawings or sequence of operation, provide slider with $\pm$ programmable scale
 5. Where a local display is indicated on the drawings or sequence of operation, the sensor shall incorporate LCD display for viewing the space temperature.
 6. Where digital setpoint adjustment and/or other operator selectable parameters are indicated on the drawings or sequence of operation, provide a sensor with built in buttons and digital display. The sensor shall be programmable to provide custom function as specified.
 7. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless-steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
 8. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
 9. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
- C. Humidity Sensors:
1. Humidity sensors shall be polymer resistance type.
 2. Space humidity sensors shall have a sensing range of 05 to 95% with accuracy of $\pm 2\%$ RH.
 3. Duct sensors and Outdoor air humidity sensors shall have a sensing range of 05 to 95% RH with accuracy of $\pm 3\%$ RH. Sensors shall be suitable for ambient temperature conditions of -40 to 212°F .
 4. Equipment shall be able to demonstrate that accuracy is NIST traceable calibration.
- D. Pressure Sensors:
1. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to $\pm 1\%$ of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Schneider model EPU305.
 2. Liquid pressure or differential liquid pressure measurements shall be accurate to $\pm 0.25\%$ of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Schneider model EPWR420-LCD.
 3. Steam pressure measurements shall be accurate to $\pm 0.13\%$ of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-207.
- E. Airflow Probes:
1. Provide an array of airflow traverse probes where indicated, capable of continuously monitoring the fan or duct capacities (CFM) they serve. Each airflow traverse probe shall contain multiple total and static pressure sensors located along the exterior surface of the cylindrical probe and internally connected to their respective averaging manifolds. The flow sensors shall not protrude beyond the surface of the probe(s) and shall be the offset type for static pressure and the chamfered impact type for total pressure measurement. The airflow sensing probe's measurement accuracy shall not be affected by directional flow having pitch and/or yaw angles up to 30° . Each airflow traverse probe shall be of extruded aluminum construction and furnished with mounting plate(s), gasket and signal fittings suitable for HVAC duct installation.

2. The airflow traverse probe shall not induce a pressure drop in excess of 0.03" w.c. at 2000 FPM, nor measurably contribute to sound levels within the duct. Total and static pressure sensors shall be located at the centers of equal areas (for rectangular duct) or at equal concentric area centers (for circular ducts) along the probe length. The airflow traverse probe shall be capable of producing steady, non-pulsating signals of total and static pressure without need for flow corrections or factors, with an accuracy of 2-3% of actual flow, over a velocity range of 400 to 4000 FPM.
 3. Provide the minimum number of probes indicated: Duct height 8 – 12", 1 probe; 13 – 30", 2 probes; 31 – 54", 3 probes; 55 – 84", 4 probes; 85 – 120", 5 probes; 121 – 180", 6 probes.
 4. The airflow traverse probe shall be the VOLU-probe as manufactured by Air Monitor Corporation, or equivalent.
- F. Liquid Flow Measurement:
1. Hi Liquid flow measurement devices shall be accurate to +/- 0.75% over a turn down ratio of 10:1. Insertion probe sensing element shall be made of 316l stainless steel. The sensing element shall have an elliptical shape that eliminates the separation point at a fixed or variable location ahead of the static pressure pick up point. Device shall only require one welded insert to mounted to piping system. Acceptable manufacturer shall be Preso, model BAR.
- G. High Limit Thermostats:
1. High limit thermostats shall be located as directed and shall be manual reset type set at 120°F in the return and 180°F in the discharge. Thermostats shall be double pole so as to provide input capability for alarm at the BAS.
- H. Low Limit Thermostats:
1. Safety low limit thermostats shall be vapor pressure type with a 20-foot minimum element. Element shall respond to the lowest temperature sensed by any one-foot section. Provide one thermostat for each 25 square foot of coil area.
 2. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
- I. Current Sensing Status Switches:
1. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.
- J. Current Measurement Devices:
1. Measurement of three-phase power shall be accomplished with a kW/kWh transducer. The instrument shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWh). Provide Veris Model 6000 Power Transducer or approved equal.
- K. Carbon Monoxide and Carbon Dioxide Sensing Devices:
1. Space or duct mounted carbon dioxide (CO₂) sensor shall be a dual element thermally compensated Lithium Tantalate IR detector and shall contain an on board relay with field adjustable trip point and adjustable time delay. The sensor shall monitor CO₂ over a range of 0 – 3000 PPM, have an accuracy of +/-3% and operate within the range of 32-104°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%, a repeatability of no more than +/-20 PPM and a drift of no more than +/-2%. The sensor shall have a green LED for normal operation, and a red LED for relay, and a reset button. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and field adjustable settings. Veris Product # CWE or equivalent.
 2. Wall mounted carbon monoxide (CO) sensor shall be microprocessor based (12-bit accuracy) and shall monitor CO over a range of 0-300 PPM (optional 200-500 PPM). The device shall have an accuracy of +/-3% (electrochemical type) or +/-5% (solid state type) and operate within the range of 32-122°F and 0-95% RH. The sensor shall have a calibration accuracy of 0.5%. Where required by the drawings or specifications, provide an LCD display for displaying PPM level and system configuration information and/or audible alarm with programmable trip point and disable jumper. Dwyer Product # GSTA-C-Dor equivalent.

- L. Refrigerant Loss Monitor
 - 1. Provide infrared refrigerant loss monitor to allow compliance with ASHRAE 15. Monitor shall detect all halogen based refrigerants, and refrigerant types shall be field changeable without recalibration. Monitor shall provide continuous digital display of system status and shall provide analog output for remote monitoring. Provide system malfunction detection and indication, and visual alarm indication. SenTech Series IR-SNIF or equivalent.
- M. Pneumatic Digital Transducers:
 - 1. Device shall provide a pneumatic output proportional to an analog output signal generated by the computer controller. Software algorithms shall compute the position of the actuator and the actuator shall be adjusted to that position. "Bleed Feed" Transducers that do not respond proportionally to a computed proportional output of the computer are not acceptable.
 - 2. Device shall fail to Zero PSI on power or signal failure
 - 3. Device shall use no air at steady state output position
 - 4. Device shall be provided with Zero and Span adjustment and Manual override positioning capability.
 - 5. Device shall be capable of generating a 0 to 10Vdc analog output proportional to pneumatic output
- N. Control Valves:
 - 1. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping.
 - 2. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
 - 3. Trim material shall be stainless steel.
 - 4. Actuators on all control valves shall be spring return to normal position pneumatic unless specifically stated otherwise. Actuators shall be sized to retain offset between nominal and actual spring range to 1.5 PSI.
 - 5. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
 - 6. Pneumatic actuators for two position radiation control, isolation of unit heaters or cabinet heaters shall be 2" diameter.
 - 7. For all other control valves, the pneumatic actuator shall be nominal 4" in diameter or larger as required to conform with nominal to actual spring range shift tolerance specified.
 - 8. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
 - 9. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.
- O. Dampers:
 - 1. Automatic dampers furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
 - 2. Damper frames shall be hat shaped channel, 4" deep constructed of 16-gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
 - 3. Damper blades shall be 16-gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.
 - 4. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated, and chromate treated pivots. Provide a 1/4-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12-gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.

5. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are ½" diameter cadmium plated steel, extendable 6".
 6. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
 7. Control dampers shall be Ruskin, Arrow or approved equal.
 8. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.
- P. Electric Thermostats: Provide a low voltage thermostat for control of single zone heating and air conditioning unit as specified in the sequence of operation. Electric thermostats shall include a display of the current space temperature as well as a mechanism for adjusting the setpoint locally. Aquastats on unit heaters shall stop the fan when the water temperature is below 100°F. The control contractor may provide full DDC control of the unit heaters in lieu of electric thermostats and use the global water temperature for low temperature interlock if it is offered at no change in price.
- Q. Steam Flow Measuring- Yokagawa Vortex Shedding Flow Meter per application.
- R. Hot or Chilled Water Flow Measuring- Onicon Electromagnetic Meters, F-3500 series.

PART 3 – EXECUTION

3.1 CONTRACTOR RESPONSIBILITIES

- A. General: Installation of the building automation system shall be performed by the Temperature Controls Contractor or a Subcontractor. However, all installation shall be under the personal supervision of the Temperature Controls Contractor. The Temperature Controls Contractor shall certify all work is proper and complete. The design, scheduling, coordination, programming, training, and warranty requirements for the project be performed by the Temperature Controls Contractor.
- B. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.
- C. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.

3.2 WIRING, CONDUIT AND CABLE

- A. ALL wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 26 (Electrical division) specification.
 1. All temperature control cable less than 50 volts is to be considered low voltage.
 2. All low voltage cable is to be run in conduit in any non-accessible concealed space and within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
 3. Conduit sleeves shall be run through any concrete or block walls for low voltage cable to be run through such walls.
 4. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
 5. All runs of multi-conductor low voltage wiring shall have at least one pair of spare conductors.
 6. Any cable running in plenum rated areas shall be plenum rated cable.
 7. Infinet and BacNET communication wiring shall be Cardinal Supply PN F2401-L120 or Connect Air PN W241P-2050FRIB.

8. BacNET IP communication wiring shall be Schneider PN ACT4P6UCP1ARXGR.
9. Sensor wiring shall be 300 Volt 18 Ga. Min., Twisted, Stranded, 2-Conductor Plenum Rated Wiring. Cardinal Supply PN D1801 or equivalent.
10. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum rated coaxial cable when running in return air plenums.
11. Fiber optic cable shall include the following sizes; 50/125, 62.5/125 or 100/140.
12. Only glass fiber is acceptable, no plastic will be allowed.
13. Fiber optic cable shall only be installed and terminated by an experienced contractor.
14. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
15. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
16. Metallic surface raceway may be used in finished areas on non accessible masonry walls AS APPROVED BY OWNER AND/OR ARCHITECT/ENGINEER. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturer's colors.

3.3 SENSOR AND ENCLOSURE LOCATIONS

- A. The location of sensors is per mechanical and architectural drawings.
- B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light and diffuser air streams.
- C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight is minimized.
- D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.4 HARDWARE INSTALLATION

- A. Installation Practices for Field Devices:
 1. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
 2. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
 3. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
 4. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
 5. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.
 6. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. The low-pressure port shall be piped to the outside of the building.
- B. Enclosures:
 1. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture and conceals integral wiring and moving parts.
 2. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
 3. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.
 4. All outside mounted enclosures shall meet the NEMA-4 rating.
 5. Provide all FIP locations on as built drawings. Drawings shall indicate FIP location, panel number and where power is being supplied from.

6. Provide adhesive label on all FIP panels indicating where source power panel originates from and number of circuit breaker.
7. FIP enclosure shall have Arc Flash covers on all circuits over 120 volts.
8. All FIPs located above and in concealed accessible locations shall have a marking sticker indicating a panel is above the acoustical dropped ceiling or access panel.
9. Mount FIPs in locations where door on FIP can be opened completely to allow access to panel components.

3.5 SOFTWARE INSTALLATION

- A. General: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third-party software necessary for successful operation of the system.
- B. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by the point list and sequence of operation.
- C. Graphic user interface: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays as depicted in the schematic drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.

3.6 EXISTING CONTROL DEVICES

- A. The bid for the control work shall be based on the premise that existing control devices (i.e. valves & damper operators) are operational and are not in need of repair or replacement, unless otherwise noted.
 1. This contractor shall notify the Owner's Representative of existing control devices that need to be replaced or repaired that may be noticed in the process of installation of new work.

3.7 COMMISSIONING AND SYSTEM STARTUP

- A. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
- B. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
- C. System Acceptance Testing:
 1. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
 2. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes sequence of operation for:
 - 1. Time Schedule Programs
 - 2. Alarm Points.
 - 3. Optimum start-stop.
 - 4. Setbacks
 - 5. Maintenance Management
 - 6. Scheduling
 - 7. Economizer Description

1.2 SUBMITTALS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures.
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
 - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
 - 2. Submit flow diagrams for each control system, graphically depicting control logic.
 - 3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
 - 4. Coordinate submittals with information requested in Section 23 09 23.

1.3 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

2.1 NOT USED.

PART 3 EXECUTION

3.1 TIME SCHEDULE PROGRAMS

- A. The programs for the EMS shall schedule each systems operation on an hourly basis controlled through daily, weekly and/or monthly schedules. Schedules for each individual system, room or area shall be easily programmed and modified by the user on a calendar-like display at the host computer.
- B. The programs shall store 60 months of schedules.
- C. An internal time clock shall automatically compensate for daylight savings time and calendars generated by software shall automatically compensate for leap years.

3.2 ALARM POINTS

- A. All temperature inputs to the DDC system (space, return air, mixed air, discharge air) shall be alarmed at the host computer if the temperature is out of range 10° F. (adj.) above or below setpoint.
- B. Fan status shall be monitored by a current sensing switch or differential pressure switch. If the fan is scheduled to run and the status is not proven, an alarm condition shall be shown at the host computer.
- C. Other alarm points are specifically addressed per individual sequences of operation.
- D. All points can be individually alarmed as required by owner's staff.

3.3 OPTIMUM START PROGRAM

- A. Each system shall have independent modular program.
- B. The program shall minimize the total energy consumption during daily start-up of each heating/cooling system.
- C. A control algorithm shall compare the outside air temperature to space temperature to calculate start time for each air handling system.
- D. The start time for each system shall bring its respective zone to occupied setpoint at the time of occupied mode start.
- E. The optimum start program shall be adjustable to the rate structure of the local energy company.

3.4 OPTIMUM STOP PROGRAM

- A. Each system shall have independent modular program.
- B. The program shall minimize the total energy consumption during daily shut-down of each heating/cooling system. A control algorithm shall compare the outside air temperature to space temperature to calculate a stop time for each air handling system.
- C. The stop time for each system shall shut-down its respective zone as early as possible without letting the temperature drift out of the specified comfort range.

3.5 DAY/NIGHT SETBACK

- A. The day/night setback will consist of lowering the space heating setpoint and raising the space cooling setpoint during the unoccupied mode, thereby reducing the heating and cooling energy requirements. The occupied and unoccupied areas will be specified by the owner, and will be coordinated with the control system.

3.6 MAINTENANCE MANAGEMENT

- A. The control system will continuously totalized hours for selected equipment controlled and/or monitored for use by the maintenance management program.

3.7 EQUIPMENT SCHEDULING

- A. Equipment shall be 7 days, 24 hours schedules with separate holiday hours.
- B. There shall be capability for five different holiday schedules which can be selected from the occupancy schedule graphic.
- C. Holidays shall be programmed so that they shall need a minimum of manual adjustment year to year, and can easily be modified at front end if necessary.
- D. All schedule programming shall reside in local controllers, but shall be configurable from the front end.

3.8 ECONOMIZER DESCRIPTION

- A. Economizer Sequence:
 - 1. The economizer shall be enabled anytime the unit is in the cooling mode. The economizer shall open the outside air damper to cool the space until the outdoor air enthalpy exceeds return air enthalpy or the outdoor air temperature exceeds 75 degrees F. Once one of the two conditions are met then the unit shall change to mechanical cooling mode.
- B. Economizer Fault Detection:
 - 1. The following temperature sensors shall be permanently installed to monitor system operation:
 - a. Outside air.
 - b. Supply air.
 - c. Return air.
 - 2. Temperature sensors shall have an accuracy of +/- 2 degrees F over the range of 40 degrees F to 80 degrees F.
 - 3. Refrigerant pressure sensors, where used, shall have an accuracy of +/- 3% of full scale.
 - 4. The unit controller shall be configured to provide system status by indicating the following:
 - a. Free cooling available.
 - b. Economizer enabled.
 - c. Compressor enabled.
 - d. Heating enabled.
 - e. Mixed air low limit cycle active.
 - f. The value of each sensor.
 - 5. The unit controller shall be capable of manually initiated each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.
 - 6. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel, or annunciated locally on zone thermostats.
 - 7. The fault detection and diagnostics system shall be configured to detect the following faults:
 - a. Air temperature sensor failure/fault.
 - b. Not economizing when the unit should be economizing.
 - c. Economizing when the unit should not be economizing.
 - d. Damper not modulating.
 - e. Excess outdoor air.

3.9 UNIT VENTILATOR (HEATING, COOLING, VENTILATING):

- A. General:
 - 1. Unit automatically indexed to "occupied" or "unoccupied" cycle by the DDC.
 - 2. Unit automatically switches from heating to cooling modes.
- B. Heating Mode:
 - 1. Occupied cycle:
 - a. Supply air fan shall run continuously.
 - b. The outdoor air damper shall fully open to admit preset minimum quantity of outdoor air; return air damper shall modulate correspondingly.
 - c. On a fall in space temperature, the heating coil valve shall modulate open.
 - d. Upon a rise in space temperature the duct mounted heating control valve shall close.
 - e. Upon a still further rise in space temperature, the unit mounted outdoor air damper shall modulate open under economizer control to satisfy the space setpoint. The unit return air damper shall modulate closed
 - f. A mixed air low limit controller shall assume control of dampers and valves as required to maintain the desired minimum mixed air temperature.
 - 2. Unoccupied cycle:
 - a. The outdoor air damper shall remain fully-closed, return air damper fully-open, unit heating coil valve fully-open, and the supply air fan shall run intermittently at demand of room sensor to maintain reduced space temperature.

- C. Cooling Mode:
 - 1. Occupied cycle:
 - a. Supply air fan shall run continuously.
 - b. The heating valve shall be closed.
 - c. The outdoor air damper shall fully open to admit preset minimum quantity of outdoor air; return air damper shall close correspondingly.
 - d. On a rise in space temperature, the unit mounted outdoor air damper shall modulate open under control of the economizer control. The unit return air damper shall modulate closed.
 - e. Upon a still further rise in space temperature the unit mounted DX coil shall energize. The outdoor air damper shall fully open to admit preset minimum quantity of outdoor air; return air damper shall modulate correspondingly.
 - 2. Unoccupied cycle:
 - a. The unit shall be disabled.
- D. Fire shut down shall be provided by the EC via the fire alarm system and by the DDC. When unit is shut down, the outside air dampers shall close and the mixing dampers shall position to 100% return air.
 - 1. Variable Volume Air Handling Unit (cooling, reheat, ventilating)

3.10 CABINET UNIT HEATER (HEATING, VENTILATING)

- A. General:
 - 1. Unit automatically indexed to "occupied" or "unoccupied" cycle by the DDC.
 - 2. Unit automatically switches from heating to cooling modes.
- B. Heating Mode:
 - 1. Occupied cycle:
 - a. Supply air fan shall run continuously.
 - b. The outdoor air damper shall fully open to admit preset minimum quantity of outdoor air; return air damper shall close correspondingly.
 - c. On a fall in space temperature, the heating coil valve shall modulate open.
 - d. Upon a rise in space temperature the control valve shall close.
 - e. Upon a still further rise in space temperature, the unit mounted outdoor air damper shall modulate open under economizer control to satisfy the space setpoint.
 - f. A mixed air low limit controller shall assume control of dampers and valves as required to maintain desired minimum mixed air temperature.
 - g. A separate low limit sensor (discharge air) shall be installed with sensing element serpentine across the face of the coil, which shall assume control of the dampers and control valve. The outdoor air damper shall close and the return air damper shall open 100% open. The unit mounted control valve shall open 100% to the coil
 - 2. Unoccupied cycle:
 - a. The outdoor air damper shall remain fully-closed, return air damper fully-open, heating coil valve fully-open, and the supply air fan shall run intermittently at demand of room sensor to maintain reduced space temperature.
- C. Fire shut down shall be provided by the EC via the fire alarm system and by the DDC. When unit is shut down, the outside air dampers shall close and the mixing dampers shall position to 100% return air.

3.11 ROOFTOP UNIT (DEDICATED OUTDOOR AIR SYSTEM)

- A. General:
 - 1. Unit automatically indexed to "occupied" or "unoccupied" cycle by the DDC.
 - 2. Unit automatically switches from heating to cooling modes.
- B. Heating Mode:
 - 1. Occupied mode

- a. Supply and return fan shall run continuously. The DDC shall modulate the VFD on the supply and return fans to maintain constant downstream static pressure.
 - b. The rooftop unit outdoor air damper shall fully open, the return air damper shall fully close and the exhaust air damper shall fully open.
 - c. The heat recovery wheel shall start.
 - d. The unit shall modulate the heating coil to produce a constant discharge air temperature of 75 degrees (adjustable).
 - 2. Unoccupied mode
 - a. The outdoor air damper shall remain fully-closed, return air damper fully-open, exhaust air damper fully closed, the heating valve fully open and the supply fan shall run intermittently at the demand of the room sensors to maintain reduced space temperature.
- C. Cooling Mode:
- 1. Occupied mode
 - a. Supply and return fan shall run continuously. The DDC shall modulate the VFD on the supply and return fans to maintain constant downstream static pressure.
 - b. The rooftop unit outdoor air damper shall fully open, the return air damper shall fully close and the exhaust air damper shall fully open.
 - c. The heat recovery wheel shall start.
 - d. The unit shall modulate the cooling coil to produce a constant discharge air temperature of 55 degrees (adjustable).
 - e. If return air humidity exceeds 60% RH (adjustable) hot gas reheat shall modulate to dehumidify space.
 - 2. Unoccupied mode
 - a. The unit is inoperable
- D. Fire shut down shall be provided by the EC via the fire alarm system and by the DDC. When unit is shut down, the outside air dampers shall close and the mixing dampers shall position to 100% return air.

3.12 EXHAUST FAN CONTROL

- A. Exhaust fans shall be controlled by wall mounted starters/switches, thermostats or shall be started and stopped by the DDC system. Refer to schedule for related control schemes.
 - 1. If the fan to run by the DDC system and run indication is not met after 2 minutes or fan run indication fails after being proven, an alarm shall be generated at the operator workstation. The call to run shall be turned off.
 - 2. All fans over 1000 CFM and serving more than one space shall be provided with fire shut downs provided by the EC via the fire alarm system. All fans under DDC control shall also shut-down. When the exhaust fan is shut down from fire alarm, the automatic air dampers shall close.

END OF SECTION

SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, buried.
- C. Heating water piping, above grade.
- D. Equipment drains and overflows.
- E. Pipe hangers and supports.
- F. Unions, flanges, mechanical couplings, and dielectric connections.
- G. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.

1.2 RELATED REQUIREMENTS

- A. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- B. Section 23 07 19 - HVAC Piping Insulation.

1.3 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators; 2023, with Errata (2024).
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2021.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- E. ASME B31.9 - Building Services Piping; 2020.
- 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 B32 - Standard Specification for Solder Metal; 2020.
- I. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- J. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- 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); 2020.
- M. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40; 2023.
- N. ASTM D2467 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80; 2020.
- O. 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.
- P. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 2024.
- Q. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2019).
- R. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- S. AWS D10.12M/D10.12 - Guide for Welding Mild Steel Pipe; 2000.
- T. AWWA C606 - Grooved and Shouldered Joints; 2022.
- U. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2018, with Amendment (2019).

1.4 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.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 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.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Valve Repacking Kits: One for each type and size of valve.

1.6 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 five years of experience.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

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

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two packing kits for each size and valve type.

PART 2 PRODUCTS

2.1 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 joining dissimilar metals.
 - 3. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 - 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. In heating water, chilled water, or condenser water systems, butterfly valves may be used interchangeably with gate and globe valves.

5. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.

E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.2 HEATING WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
 2. Threaded Joints: ASME B16.3, malleable iron fittings.
 3. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Steel Pipe Sizes 12 Inches and Greater: ASTM A53/A53M, 3/8 inch wall, black, using one of the following joint types:
 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D10.12M/D10.12 welded.
 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- C. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M, Schedule 40 galvanized; using one of the following joint types:
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- C. 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.

2.4 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.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.

2.5 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. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
4. When pipe is field grooved, provide coupling manufacturer's grooving tools.

2.6 BALL VALVES

- A. 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.

2.7 BUTTERFLY VALVES

- A. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- B. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- C. Operator: 10 position lever handle.

2.8 SWING CHECK VALVES

- A. Up To and Including 2 Inches:
 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
- B. Over 2 Inches:
 1. Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.

2.9 SPRING LOADED CHECK VALVES

- A. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat, solder or threaded ends.
- B. 2-1/2 inches and Larger: MSS SP 71, Class 125, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Slope piping and arrange to drain at low points.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. 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 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 inches 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. See Section 09 9123. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 23 07 19.
- K. Use eccentric reducers to maintain top of pipe level.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- M. Install valves with stems upright or horizontal, not inverted.

3.3 TESTING

- A. All piping shall be tested in accordance with the applicable Mechanical Code.
- B. Hydronic piping shall be tested hydrostatically at one and one half times the maximum system design pressure, but not less than 100 psi. Test duration shall be no less than 15 minutes.

3.4 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 5. 3 Inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.

END OF SECTION

SECTION 23 21 14
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Strainers.
- B. Automatic flow control valves.
- C. Flow meters.
- D. Relief valves.

1.2 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.

1.3 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250; 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard; 2020.
- C. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded; 2021.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023, with Errata (2024).

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.5 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum week prior to commencing work of this section.

1.6 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.7 FIELD MEASUREMENTS

- A. Verify field measurements before fabrication.

1.8 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for piping specialties.

1.9 MAINTENANCE SERVICE

- A. Section 01 70 00 - Execution and Closeout Requirements: Maintenance service.
- B. Furnish service and maintenance of glycol fluid and glycol charging components for two years from Date of Substantial Completion.
- C. Furnish monthly visit for one year starting from Date of Substantial Completion to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two bottles of red gage oil for static pressure gages.
- C. Furnish two pressure gages with pulsation damper and two thermometers .
- D. Furnish two extra 55 gallon drums of propylene glycol.

1.11 QUALITY ASSURANCE

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

1.12 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

2.1 STRAINERS

- A. Size 2 inch and Under:
 - 1. Provide threaded, grooved, or sweat brass or iron body for up to 175 psi working pressure, Y-pattern strainer with 1/32 inch stainless steel perforated screen.
- B. Size 2-1/2 inch to 4 inch:
 - 1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 1/16 inch or 3/64 inch stainless steel perforated screen.
- C. Size 5 inch and Larger:

1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.2 AUTOMATIC FLOW CONTROL VALVES

- A. Manufacturers:
 1. Bell & Gossett, a brand of Xylem, Inc; Circuit Sentry Flo-Setter II: www.bellgossett.com/#sle.
 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Construction:
 1. Valve shall be capable of Class IV shut off without the use of an additional shut-off valve.
 2. Valve Body:
 - a. 1/2 inch through 1-1/4 inch: DZR brass.
 - b. 1-1/2 inch through 2 inch: Ductile iron.
 3. Valve Diaphragm: HNBR.
 4. Two integral pressure/temperature ports.
 5. Dial indicating setting in gallons per minute.
 6. Stainless steel stem with field adjustable locking handle.
- C. Valve Ratings:
 1. Working Pressure: 375 PSIG.
 2. Temperature Range: 14 to 250 degrees F.
 3. Differential Pressure Control Range: 60 psi.
- D. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- E. 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.

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Refer to drawing for required specialties.
- B. Locate test plugs adjacent to thermometers and thermometer sockets and adjacent to pressure gages and pressure gage
- C. Where large air quantities accumulate, provide enlarged air collection standpipes.
- D. Install manual air vents at system high points.
- E. For automatic air vents in ceiling spaces or other concealed locations, install vent tubing to nearest drain.
- F. Provide air separator on suction side of system circulation pump
- G. Connect to expansion tank to system by pipe connected of the bottom of the pump suction line.
- H. Provide drain and hose connection with valve on strainer blow down connection.
- I. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.

- J. Support pump fittings with floor mounted pipe and flange supports.
- K. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- L. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- M. Pipe relief valve outlet to nearest floor drain.
- N. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- O. Feed glycol solution to system through make-up line with pressure regulator, venting system high points. Set to fill at 15 psig.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test for strength of glycol and water solution and submit written test results.

3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean and flush glycol system before adding glycol solution.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting installed construction.
- B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Check valves.
- G. Pressure relief valves.
- H. Filter-driers.
- I. Solenoid valves.
- J. Expansion valves.
- K. Receivers.
- L. Flexible connections.

1.2 RELATED REQUIREMENTS

- A. Section 23 07 19 - HVAC Piping Insulation.

1.3 REFERENCE STANDARDS

- A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers; 2005.
- B. AHRI 730 (I-P) - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers; 2013 (Reapproved 2014).
- C. AHRI 760 (I-P) - Performance Rating of Solenoid Valves for Use with Volatile Refrigerants; 2014.
- D. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; 2024, with Errata (2025).
- E. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants; 2024.
- F. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels; 2023, with Errata (2024).
- G. 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).
- H. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2021.
- I. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes; 2024.
- J. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; 2022.

- K. ASME B31.9 - Building Services Piping; 2020.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2020.
- N. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.
- O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- P. UL 429 - Electrically Operated Valves; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
- H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1.11 MAINTENANCE MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two refrigerant oil test kits each containing everything required for conducting one test.

1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two refrigerant filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Filter-Driers:
 - 1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.

2.2 REGULATORY REQUIREMENTS

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

2.3 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.
- B. Copper Tube to 7/8-inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
 - 1. Fittings: ASME B16.26 cast copper.
 - 2. Joints: Flared.
- C. Pipe Supports and Anchors:
 - 1. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 - 2. Vertical Support: Steel riser clamp.
 - 3. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 - 4. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.4 MOISTURE AND LIQUID INDICATORS

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

2.5 VALVES

- A. Diaphragm Packless Valves:
 - 1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, soldered or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Service Valves:
 - 1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or soldered ends, for maximum pressure of 500 psi.

2.6 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.7 CHECK VALVES

- A. Globe Type:
 - 1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 500 psi.
- B. Straight Through Type:
 - 1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 250 degrees F.

2.8 PRESSURE RELIEF VALVES

- A. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 450 psi.

2.9 FILTER-DRIERS

- A. Performance:
 - 1. Design Working Pressure: 500 psi, minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
- C. Construction: UL listed.
 - 1. Connections: As specified for applicable pipe type.

2.10 SOLENOID VALVES

- A. Valve: AHRI 760 (I-P), pilot operated, copper, brass or steel body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, soldered, or threaded ends; for maximum working pressure of 500 psi.

2.11 EXPANSION VALVES

- A. Angle or Straight Through Type: AHRI 760 (I-P); design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with nonreplaceable capillary tube and remote sensing bulb and remote bulb well.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.12 RECEIVERS

- A. Internal Diameter 6 inch and Smaller:
 - 1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.
- B. Internal Diameter Over 6 inch:
 - 1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.13 FLEXIBLE CONNECTORS

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

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. 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.
- F. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Provide access to concealed valves and fittings.
- I. Fully charge completed system with refrigerant after testing.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Test refrigeration system piping following requirements of manufacturer of connected equipment, in accordance with procedures outlined in ASME B31.5 and meeting minimum pressures provided therein, or manufacturer's documentation, whichever is greater.
- C. Test and repair to no leakage.

3.4 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- C. Section 23 33 00 - Air Duct Accessories.

1.3 REFERENCE STANDARDS

- A. ASHRAE (FUND) - ASHRAE Handbook - Fundamentals; Most Recent Edition Cited by Referring Code or Reference Standard.
- B. ASHRAE Std 126 - Method of Testing HVAC Air Ducts; 2020.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- E. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- F. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- G. ASTM D7803 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating; 2012 (Reapproved 2019).
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- I. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2018, with Editorial Revision (2020).
- J. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry; 2018, with Editorial Revision (2020).
- K. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2017, with Editorial Revision (2020).
- L. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2023.
- M. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- N. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.

- O. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2024.
- P. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- Q. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines; 2001.
- R. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012.
- S. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all modifications / systems. Contractor will be responsible for any rework of shop drawings due to field conditions prior to approval of drawings. Contractor shall field verify field conditions prior to submitting shop drawings.
- D. Samples: Submit RAL color charts for powder coat selection and verification prior to fabrication.
- E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
- F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.5 CLOSEOUT SUBMITTALS

- A. See Section 01 70 00 - Execution and Closeout Requirements for closeout procedures.

1.6 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 five years of documented experience.
- C. Maintain one copy of each document on site.

1.7 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.
- C. Provide offsets as required for installation of ductwork due to field conditions.

1.8 WARRANTY

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

1.9 FIELD MEASUREMENTS

- A. Verify field measurements of all duct installations prior to fabrication.

PART 2 PRODUCTS

2.1 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. Provide metal duct unless otherwise indicated.
- C. Duct Shape and Material in accordance with Allowed Static Pressure Range:
 - 1. Rectangular: Plus or minus 4 in-wc of galvanized steel.
- D. Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
 - a. Supply Air: 4 in-wc pressure class, galvanized steel.
 - b. Outside Air Intake: 4 in-wc pressure class, galvanized steel.
 - c. Return and Relief Air: 4 in-wc pressure class, galvanized steel.
 - d. General Exhaust Air: 1 in-wc pressure class, galvanized steel.
 - e. Transfer-air and Sound Booths: 1/2 in-wc pressure class, fibrous glass.
 - 2. Low Pressure Service: Up to 2 in-wc:
 - 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.
 - 3. Low Pressure Service: From 2 in-wc to 3 in-wc:
 - 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.
 - 4. 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.
- E. Duct Fabrication Requirements:
 - 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - 2. No variation of duct configuration or size permitted except by written permission. Size round duct installed in place of rectangular ducts in accordance with ASHRAE (FUND) Handbook - Fundamentals.
 - 3. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - 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. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.

8. 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.

2.2 PAINTED FINISHES:

- A. Where exposed metal ducts within finished spaces are indicated to be finished, all exposed portions shall be manufactured and treated as indicated:
 1. Field Painted Finishes:
 - a. Base metal shall be galvanized steel to promote paint adhesion.
 - b. Ducts and associated fittings shall be cleaned at time of installation to remove dirt and oils that would inhibit proper adhesion.
 - c. Field painting to be provided by other trades.
 2. Shop Powder Coated Finishes:
 - a. Base metal shall be galvanized steel to promote adhesion, with flanged construction for field assembly, length of 10 feet maximum.
 - b. Surfaces shall be prepared in accordance with ASTM D7803, including but not limited to pre-treatment cleaning, application of corrosion inhibitors, and pre-bake.
 - c. Powder coating to be applied at 3 - 6 mils thick prior to baking for proper cure.
 - d. Color: As selected by Architect/Engineer from full RAL spectrum.

2.3 METAL DUCTS

- A. Material Requirements:
 1. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
 2. Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with A40/ZF120 coating.
 3. Aluminum: ASTM B209/B209M, aluminum sheet, alloy 3003-H14.
 4. Stainless Steel: ASTM A666, Type 304.
- B. Rectangular Metal Duct:
 1. Rectangular Double Wall Insulated: Rectangular spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
 - a. Insulation:
 - 1) Thickness: 1 inch.
 - 2) Material: Fiberglass.
- C. 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; fitting with the solid inner wall.
 - a. Insulation:
 - 1) Thickness: 1 inch.
 - 2) Material: Fiberglass.
 3. Round Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
- D. Round Spiral Duct:
 1. Round spiral lock seam duct with galvanized steel outer wall.
- E. 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. VOC Content: Not more than 250 g/L, excluding water.
 - c. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - d. For Use with Flexible Ducts: UL labeled.
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.
6. Hanger Fasteners: Attach hangers to structure using appropriate fasteners as follows:
 - a. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - b. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
 - c. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
 - d. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
 - e. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

2.4 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 5 in-wc negative.
 3. Maximum Velocity: 5500 fpm.
 4. Temperature Range: Minus 20 degrees F to 250 degrees F.

2.5 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.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install products following the manufacturer's instructions.
- B. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.

- C. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- D. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- E. Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
- F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with a crimp in the direction of airflow.
- H. Use double nuts and lock washers on threaded rod supports.
- I. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- J. 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.
- K. Set plenum doors at 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.
- L. At exterior wall louvers, seal duct to louver frame and transition to louver frame size.
- M. Duct Insulation: Provide duct insulation. See Section 23 07 13.

3.2 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Clean duct systems with high-power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters or bypass during cleaning. Provide adequate access to the ductwork for cleaning purposes.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Combination fire and smoke dampers.
- D. Duct access doors.
- E. Duct test holes.
- F. Fire dampers.

1.2 RELATED REQUIREMENTS

- A. Section 23 31 00 - HVAC Ducts and Casings.

1.3 REFERENCE STANDARDS

- A. ICC (IMC)-2015 - International Mechanical Code; 2015.
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- C. NFPA 92 - Standard for Smoke Control Systems; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.
- E. UL 33 - Safety Heat Responsive Links for Fire-Protection Service; Current Edition, Including All Revisions.
- F. UL 555 - Standard for Fire Dampers; Current Edition, Including All Revisions.
- G. UL 555S - Standard for Smoke Dampers; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - 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, duct access doors, and duct test holes.
- D. Manufacturer's Installation Instructions: Provide instructions for fire dampers and combination fire and smoke dampers.
- E. Project Record Drawings: Record actual locations of access doors and test holes.
- F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements for additional provisions.

2. Extra Fusible Links: One of each type and size.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit for Fire Dampers.

1.6 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. Dampers tested, rated and labeled in accordance with the latest UL requirements.
- C. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
- D. Maintain one copy of each document on site.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.
- B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- C. Storage: Store materials in a dry area indoor, protected from damage.
- D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work where appropriate with building control Work.

PART 2 PRODUCTS

2.1 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.2 BACKDRAFT DAMPERS - METAL

- A. Manufacturers:
 1. Louvers & Dampers, Inc, a brand of Mestek, Inc: www.louvers-dampers.com/#sle.
 2. Nailor Industries, Inc: www.nailor.com/#sle.
- B. Gravity Backdraft Dampers, Size 18 x 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.

2.3 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc: www.nailor.com/#sle.
 - 2. PCI Industries, Inc; Pottorff Brand : www.portorff.com.
 - 3. Ruskin Company, a brand of Johnson Controls: www.ruskin.com/#sle.
- B. 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.
- C. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.

2.4 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Access doors with sheet metal screw fasteners are not acceptable.

2.5 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.

2.6 FIRE DAMPERS

- A. Manufacturers:
 - 1. Nailor Industries, Inc: www.nailor.com/#sle.
 - 2. PCI Industries, Inc; Pottorff Brand : www.portorff.com.
 - 3. Ruskin Company, a brand of Johnson Controls: www.ruskin.com/#sle.
- B. 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.
- C. Fusible Links: UL 33, separate at 160 degrees F with adjustable link straps for combination fire/balancing dampers.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). See Section 23 31 00 for duct construction and pressure class.

- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide 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.

END OF SECTION

SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Roof exhausters.

1.2 RELATED REQUIREMENTS

- A. Section 23 31 00 - HVAC Ducts and Casings.
- B. Section 23 33 00 - Air Duct Accessories: Backdraft dampers.

1.3 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B. AMCA 99 - Standards Handbook; 2016.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016, with Errata (2018).
- E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on fans and accessories, including fan curves with specified operating point plotted, power, rpm, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Manufacturer's Instructions: Indicate installation instructions.
- D. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Loren Cook Company: www.lorencook.com/#sle.

2.2 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.

2.3 ROOF EXHAUSTERS

- A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- B. Roof Curb: 8 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- C. Disconnect Switch: Factory wired, nonfusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- D. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with cadmium plated steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Provide sheaves required for final air balance.
- E. Install backdraft dampers on inlet to roof and wall exhausters.

END OF SECTION

SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rectangular ceiling diffusers.
- B. Registers/grilles:
 - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
 - 2. Wall-mounted, supply register/grilles.
- C. Louvers.
- D. Roof hoods.

1.2 REFERENCE STANDARDS

- A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating; 2023.
- 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.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Project Record Documents: Record actual locations of air outlets and inlets.
- D. Test Reports: Rating of air outlet and inlet performance.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 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.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Price Industries: www.price-hvac.com/#sle.
- B. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Type: Provide square, adjustable pattern, stamped, multi-core diffuser to discharge air in 360 degree pattern with sectorizing baffles where indicated.
- B. Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel with baked enamel finish.
- D. Color: As selected by Architect from manufacturer's standard range.
- E. Accessories: Provide radial opposed blade volume control damper; removable core, sectorizing baffle, and gaskets for surface mounted diffusers with damper adjustable from diffuser face.

2.3 CEILING EGG CRATE EXHAUST AND RETURN GRILLES

- A. Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch and 1 by 1 by 1 inch grid core.
- B. Fabrication: Grid core consists of aluminum with mill aluminum finish.
- C. Color: To be selected by Architect from manufacturer's standard range.

2.4 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, single 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: To be selected by Architect from manufacturer's standard range.
- E. Damper: Integral, gang-operated opposed blade type with removable key operator, operable from face.

2.5 LOUVERS

- A. Type: 4 inch 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.
- B. Color: To be selected by Architect from manufacturer's standard range.
- C. Mounting: Furnish with interior flat flange for installation.

2.6 ROOF HOODS

- A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).
- B. Fabricate louver penthouses with mitered corners and reinforce with structural angles.
- C. Mount unit on minimum 12 inch high wind rated curb base with insulation between duct and curb.
- D. Make hood outlet area minimum of twice throat area. Sizes indicated on Drawings are throat size.

PART 3 EXECUTION

3.1 INSTALLATION

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

3.2 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.

3.3 PROTECTION

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

END OF SECTION

SECTION 23 74 33
DEDICATED OUTDOOR AIR UNITS

PART 1 - GENERAL

1.1 REFERENCE STANDARDS

- A. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2016, with Errata (2018).
- B. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi; 2015, with Editorial Revision (2021).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2024.
- D. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2024.
- E. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; Current Edition, Including All Revisions.
- F. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.2 SUMMARY

- A. This section includes units for outdoor installation. Integral Energy Recovery device shall be an air-to-air total enthalpy core. Integral heat source shall be air-source heat pump with electric heat. Integral cooling source shall be air-source heat pump. Airflow arrangement shall be Outdoor Air only. Each unit shall incorporate additional product requirements as listed in Section 2 of this specification.

1.3 SUBMITTALS

- A. Product Data: For each type or model include the following:
 - 1. Complete fan performance curves for both Supply Air and Exhaust Air, with system operating conditions indicated, as tested in an AMCA certified chamber.
 - 2. Sound performance data for both Supply Air and Exhaust Air, as tested in an AMCA certified chamber.
 - 3. Motor ratings, electrical characteristics and motor and fan accessories.
 - 4. Dimensioned drawings for each type of installation, showing isometric and plan views, to include location of attached ductwork and service clearance requirements.
 - 5. Estimated gross weight of each installed unit.
 - 6. Installation, Operating and Maintenance manual (IOM) for each model.
 - 7. Microprocessor Controller (DDC) specifications to include available options and operating protocols. Include complete data on all factory-supplied input devices.
 - 8. Energy recovery performance data for both summer and winter operation.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain unit with all appurtenant components or accessories from a single manufacturer.
- B. For the actual fabrication, installation, and testing of work under this section, use only thoroughly trained and experienced workers completely familiar with the items required and with the manufacturer's current recommended methods of installation.
- C. Product Options: Drawings must indicate size, profiles and dimensional requirements of unit and are to be based on the specific system indicated. Refer to Division 1 Section "Product Requirements".

- D. End of line test with full report available upon request.
- E. Certifications
 - 1. Entire unit shall be ETL Certified per U.L. 60335-2-40 and bear an ETL sticker.
 - 2. Unit shall be AHRI Certified Dedicated Outdoor Air Units (DOAS) to AHRI 920 Standard.
 - 3. Energy Recovery Device shall be AHRI Certified, per Standard 1060.

1.5 COORDINATION

- A. Coordinate size and location of all building penetrations required for installation of each unit and associated plumbing and electrical systems.
- B. Coordinate location of water system fittings to ensure correct positioning for connection to the water coil and condensate drain pipe.
- C. Coordinate sequencing of construction of associated plumbing, HVAC, electrical supply.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with specifications contained within this document, manufacturers offering products that may be incorporated into the work include, but are not limited to:
 - 1. Valent Air Corporation, LLC
 - 2. Aaon
 - 3. Trane US Inc.

2.2 MANUFACTURED UNITS

- A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, exhaust air blower, energy core, hot gas reheat coil, air-source heat pump, motorized dampers, motorized recirculating damper, filter assembly intake air, supply air blower assembly, exhaust/relief blower assembly, filter assembly for exhaust air, and an electrical control center. All specified components and internal accessories factory installed are tested and prepared for single-point high voltage connection except with electric post heat and exhaust fan only power which have dual point power.

2.3 CABINET

- A. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - 1. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum 14 gauge galvanized (G90) steel.
- B. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - 1. Materials: Rigid urethane injected foam. Foam board not acceptable.
 - a. Thickness: 2 inch
 - b. Thermal Resistance R16
 - c. Thermally broken
 - d. Meets UL94HF-1 flame requirements.
 - e. Location and application: Full coverage of entire cabinet exterior to include walls, roof of unit, unit base, and doors.
- C. Roof Insulation: 2 inch fiberglass located above the 1 inch foam panel.
- D. Access panels / doors: Unit shall be equipped with insulated, hinged doors or removable access panels to provide easy access to all major components. Doors and access panels shall be fabricated of 18 gauge galvanized G90 steel or painted galvanized steel.

- E. Supply Air blower assemblies: Blower assembly shall consist of an electric motor and direct-drive fans. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motors shall be capable of continuous speed modulation and controlled by a VFD.
- F. Exhaust Air blower assemblies: Blower assembly shall consist of an electric motor and a direct-drive fan. Assembly shall be mounted on heavy gauge galvanized steel rails and further mounted on 1.125 inch thick neoprene vibration isolators. Blower motor shall be capable of continuous speed modulation and controlled by a VFD.
- G. Control panel / connections: Units shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections. RTU shall be equipped with a Unit Disconnect Switch. Electric heater shall have single point power.
- H. Condensate drain pan: Drain Pan shall be an integral part of the unit whenever a cooling option is included. Pan shall be formed of welded austenitic stainless steel sheet material and provided with a welded stainless steel drain connection at the front for connection to a P trap. Drain pan shall be sloped in two directions to provide positive draining and drain connector shall be sealed at penetration through cabinet wall.
- I. P trap: If the unit is equipped with a condensate drain pan, contractor shall provide, or fabricate, and install an appropriate P trap, in accordance with all local and area codes and Best Practices.
- J. Energy core: Air-to-air heat exchanger shall provide sensible and latent energy transfer in a crossflow arrangement. Heat exchanger shall be constructed of a hybrid polymer housed within a G90 galvanized frame. Heat exchanger shall have no moving parts, motors, belts, or pulleys. The material shall not promote mold or bacteria growth and must have successfully passed ASTM G21 testing.
- K. Core Frost Control: Electric Preheat: Shall be provided for frost control of the energy core. Preheater assembly shall include an outdoor air temperature sensor to initiate frost control sequence. Preheater shall comply with UL 1995 and be constructed on a galvanized steel frame.
- L. Reheat coil with factory installed modulating hot gas reheat valve.
- M. Electric Post-heater: Post-heater shall be SCR control and shall include a temperature sensor with field adjustable set point, located in the outdoor air stream. Heat output of the post-heater shall be infinitely variable. Electric post-heater cannot operate simultaneously with the air-source heat pump.
- N. Air-Source Heat Pump: Unit shall have an integral compressor(s) and indoor coil located within the weather-tight unit housing. Outdoor coils and appurtenant outdoor fan assemblies shall be factory installed as integral subassemblies of the unit and mounted on the exterior of the unit. Lead fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a refrigerant pressure set point.] Motors shall be UL Recognized and CSA Certified. The lead refrigerant compressor shall be inverter hermetic scroll-type. Additional compressor shall be single stage hermetic scroll-type paired in tandem with lead inverter compressor. Compressors shall be equipped with liquid line filter drier, individual sight glass for heating and cooling operation, electronic expansion valves (EEV), manual reset high pressure and low pressure cutouts and all appurtenant sensors, service ports, leak detection sensors and safety devices. Compressed refrigerant system shall be fully charged with R-454B refrigerant. Each compressor shall be factory-equipped with an electric crankcase heater to boil off liquid refrigerant from the oil. Digital compressors are not allowed.

- O. Condenser Fans: Fan blades must be constructed of aluminum or a composite material and have a geometry designed and documented to reduce sound and energy when compared to a traditional rectangular blade fan. Traditional rectangular blade fans are not allowed due to increased noise generated and increase power utilized. Condenser fan motors shall be three phase, external rotor, type 56 frame, open air over and shaft up. Each condenser fan motor shall have a vented frame, rated for continuous duty and be equipped with an automatic reset thermal protector. Lead condenser fan(s) will have an electronically commutated (EC) motor that will modulate to maintain a head pressure set point.] Motors shall be UL Recognized and CSA Certified. Single condenser fan running at max RPM and design static pressure shall not exceed an A-weighted sound power level of 75 db at free inlet/outlet test conditions.
- P. Motorized dampers / Intake Air, Motorized dampers of low leakage type shall be factory installed.
- Q. Service receptacle: 120 VAC GFCI service outlet shall be factory-provided and installed by this contractor in a location designated by the A / E. Service outlet requires a dedicated single phase electric circuit. Unit contains a 120 VAC transformer to provide power to service outlet.

2.4 BLOWER

- A. Blower section construction, Supply Air: direct drive motor and blower shall be assembled on a 14 gauge galvanized steel platform and shall be equipped with 1.125 inch thick neoprene vibration isolation devices.
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
- C. Fan: Direct drive, airfoil plenum fan with steel wheel statically and dynamically balanced. Prop or belt-drive fan not acceptable due to low static capabilities.
- D. Blades: Painted steel blades only.
- E. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".

2.5 MOTORS

- A. General: Blower motors greater than 1/2 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPA's minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure.
- B. Motors shall be 60 cycle, 3 phase 208 volts.

2.6 FILTERS

- A. Unit shall have permanent 2 inch aluminum filters located in the outdoor air intake and shall be accessible from the exterior of the unit. MERV 8 disposable pleated filters shall be provided in the supply air stream. MERV 8 and MERV 13 disposable pleated filters shall be provided in the supply final air stream and MERV 8 filters in the exhaust air stream.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to start of installation, examine area and conditions to verify correct location for compliance with installation tolerances and other conditions affecting unit performance. See unit IOM.

- B. Examine roughing-in of plumbing, electrical and HVAC services to verify actual location and compliance with unit requirements. See unit IOM.
- C. Proceed with installation only after all unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Installation shall be accomplished in accordance with these written specifications, project drawings, manufacturer's installation instructions as documented in manufacturer's IOM, Best Practices and all applicable building codes.

3.3 CONNECTIONS

- A. In all cases, industry Best Practices shall be incorporated. Connections are to be made subject to the installation requirements shown above.
- B. Piping installation requirements are specified in Division 22 (Plumbing). Drawings indicate general arrangement of piping, fittings and specialties.
- C. Duct installation and connection requirements are specified in Division 23 of this document.
- D. Electrical installation requirements are specified in Division 26 of this document.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A / E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.

3.5 START-UP SERVICE

- A. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, install clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.

3.6 DEMONSTRATION AND TRAINING

- A. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION

SECTION 23 81 29
VARIABLE REFRIGERANT FLOW SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Air-Source Outdoor Units.
- B. Indoor Units.
- C. Controls.

1.2 REFERENCE STANDARDS

- A. AHRI 1230 - Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment; 2021.
- B. ASCE 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; Most Recent Edition Cited by Referring Code or Reference Standard.
- C. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; 2024, with Errata (2025).
- D. ASHRAE Std 90.1 I-P-2019 - Energy Standard for Buildings Except Low-Rise Residential Buildings; 2019, with Errata and Addenda (2021).
- E. ASTM D3451 - Standard Guide for Testing Coating Powders and Powder Coatings; 2006 (Reapproved 2017).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.
- G. ISO 14001 - Environmental Management Systems — Requirements with Guidance for Use; 2015.
- H. ISO 9001 - Quality Management Systems — Requirements; 2015, with Amendment (2024).
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 1995 - Heating and Cooling Equipment; Current Edition, Including All Revisions.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's standard data sheets for each item of equipment, marked to correlate to equipment item markings indicated in Contract Documents:
- C. Operating and Maintenance Data:
 - 1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
 - 2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
 - 3. Identification of replaceable parts and local source of supply.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Warranty: Executed warranty, made out in Owner's name.

1.4 QUALITY ASSURANCE

- A. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- B. All wiring shall be in accordance with the NFPA 70.
- C. The units shall be manufactured in a facility registered to ISO 9001 and ISO 14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).
- D. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the ASHRAE Std 90.1 I-P-2019 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the Air-Conditioning, Heating, and Refrigeration Institute AHRI 1230.
- E. Manufacturer shall have a minimum of fifteen (15) years continuous experience providing VRF systems in the U.S. market.
- F. Installer Qualifications: Minimum five years experience and trained and approved by manufacturer of equipment.
- G. System start-up supervision shall be a required service to be completed by the manufacturer or a duly authorized, competent representative that has been factory trained in system configuration and operation. The representative shall provide proof of manufacturer certification indicating successful completion within no more than two (2) years prior to system installation. This certification shall be included as part of the equipment and/or controls submittals.
- H. Manufacturer shall provide on-site supervision and commissioning services for the full duration of the project at no additional cost.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored and handled according to the manufacturer's recommendation.

1.6 WARRANTY

- A. The units shall be covered by the manufacturer's limited warranty for a period of one (1) year parts and seven (7) year compressor to the Owner from date of installation. Manufacturer shall provide first year labor warranty running concurrent to first year parts warranty.
- B. Manufacturer shall provide 1st year labor warranty.
- C. Installing contractor shall meet manufacturer requirements to obtain extended manufacturer's limited parts and compressor warranty for a period of ten (10) years to the Owner from date of installation. This warranty shall not include labor.
- D. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN MANUFACTURER

- A. Mitsubishi Electric; CITY MULTI VRF zoning system: www.mitsubishicomfort.com.
- B. Or Approved Equal.
- C. Substitutions: See Section 01 60 00 - Product Requirements for substitution procedures.

2.2 OUTDOOR UNITS

- A. S-SERIES RAPID CHANGEOVER HEATING/COOLING (HEAT PUMP), AIR-COOLED OUTDOOR UNITS
1. General:
 - a. The outdoor unit modules shall be air-cooled, direct expansion (DX), multi-zone units used specifically with VRF components described in this section and Controls Article. The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards—all of which must be manufactured by the branded VRF manufacturer. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 - b. Outdoor unit shall have a sound rating no higher than 59 dB(A). If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
 - c. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
 - d. The outdoor unit shall have the capability of installing the main refrigerant piping through the bottom of the unit.
 - e. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 - f. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 - g. VRF system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
 - h. The outdoor unit shall be capable of guaranteed operation in heating mode down to -13°F ambient temperatures and cooling mode up to 115°F without additional restrictions on line length & vertical separation beyond those published in respective product catalogs. Models with capacity data for required temperature range published as "for reference only" are not considered capable of guaranteed operation and are not acceptable. If an alternate manufacturer is selected, any additional material, cost, and labor to meet ambient operating range and performance shall be incurred by the contractor.
 - i. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.
 - j. VRF four-legged outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7 gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.
 2. Unit Cabinet:
 - a. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
 - b. Outdoor unit components shall be coated with the Seacoast Protection Coating (Brine Spray – BS coating) to protect components from premature corrosion due to a seacoast environment. Coating shall be applied to components before original outdoor unit assembly to ensure manufacturer quality standards are not compromised and shall meet the following minimum requirements:
 - 1) $\geq 85\mu\text{m}$ thermoset polyester-resin powder coating on External Front Panel.
 - 2) $\geq 70\mu\text{m}$ thermoset polyester-resin powder coating on External Panel Base, Pillar, Compressor Cover, Fan Motor Support, Electrical Box.
 - 3) $\geq 1\mu\text{m}$ cellulose and polyurethane-resin coating on heat exchanger fins.
 - 4) $\geq 10\mu\text{m}$ polyurethane coating on printed circuit boards.
 - c. The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.
 - d. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised and the panel should be replaced immediately.

3. Fan:
 - a. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only.
 - b. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 - c. All fans shall be provided with a raised guard to prevent contact with moving parts.
4. Refrigerant and Refrigerant Piping:
 - a. R410A, R454BA, or R454B refrigerant shall be required for systems.
 - 1) For Class A2L refrigerants, (R454B), indoor units shall be provided with refrigerant leak detection devices factory installed that will close off electronic expansion valve at indoor unit upon leak detection. This will also lock out and deenergize all downstream electric heat.
 - b. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
 - c. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the VRF equipment manufacturer and installed in accordance with manufacturer recommendations.
 - d. All refrigerant piping must be insulated with ½" closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E84 and CAN / ULC S-102. R value of insulation must be at least 3.
 - e. Refrigerant line sizing shall be in accordance with manufacturer specifications.
5. Coil:
 - a. The outdoor coil shall be of nonferrous construction with lanced or corrugated fins on copper tubing.
 - b. The coil fins will have a factory applied corrosion resistant blue-fin finish.
 - c. The coil shall be protected with an integral metal guard.
 - d. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
6. Compressor:
 - a. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors. Non inverter-driven compressors, which may cause inrush current (demand charges) and require larger generators for temporary power shall not be allowed.
 - b. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting "belly-band" type crankcase heaters are not allowed.
 - c. Compressor shall have an inverter to modulate capacity.
 - d. The compressor shall be equipped with an internal thermal overload.
7. Controls:
 - a. The unit shall be an integral part of the system & control network described in Controls Article and react to heating/cooling demand as communicated from connected indoor units over the control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.
8. Electrical:
 - a. The outdoor unit electrical power shall be 208/230 volts, 1-phase, 60 hertz per equipment schedule.
 - b. The outdoor unit shall be controlled by integral microprocessors.
 - c. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.3 INDOOR UNITS

A. WALL MOUNTED INDOOR UNIT

1. General:

- a. The wall-mounted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.
2. Unit Cabinet:
 - a. All casings, regardless of model size, shall have the same white finish
 - b. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining are required.
 - c. There shall be a separate back plate which secures the unit firmly to the wall.
3. Fan:
 - a. The indoor fan shall be statically and dynamically balanced to run on a single motor with permanently lubricated bearings.
 - b. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 - c. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
4. Filter:
 - a. Return air shall be filtered by means of an easily removable, washable filter.
5. Coil:
 - a. Basis of design indoor units include factory-installed LEV/EEV. Alternative brands which require field-installed, accessory LEV or EEV kits are permissible only with written Engineer and Architect approval for the location of kits being submitted two weeks prior to bid date. EEV kits mounted in cavities inside fire-rated interior walls shall be mounted inside three hour fire rated enclosures with access panels supplied by the manufacturer. Enclosure type and placement require prior approval.
 - b. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
 - c. The coils shall be pressure tested at the factory.
6. Electrical:
 - a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
 - b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz)
7. Controls:
 - a. The unit shall include an IR receiver for wireless remote control flexibility
 - b. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 - c. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 - d. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 - e. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 - f. Control board shall include contacts for control of no less than two stages of external heat. The first stage of external heat may be energized when the space temperature is 2.7°F from set point for between 10-25 minutes (user adjustable). The second stage of external heat may be energized when the first stage has been active for no less than 5 minutes and the space temperature has not risen by more than 0.9°F.
 - g. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 - h. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

B. 4-WAY CEILING-RECESSED CASSETTE WITH GRILLE FOR 2X2 GRID

VARIABLE REFRIGERANT FLOW SYSTEMS

1. General:
 - a. The indoor unit shall be a four-way cassette style indoor unit that recesses into the ceiling with a ceiling grille. The indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, an emergency operation function and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL 1995.
2. Unit Cabinet:
 - a. The cabinet shall be a compact 22-7/16 inches wide x 22-7/16 inches deep so it will fit within a standard 24 inch square suspended ceiling grid.
 - b. The cabinet panel shall have provisions for a field installed filtered outside air intake.
 - c. Four-way grille shall be fixed to bottom of cabinet allowing two, three or four-way blow.
3. Fan:
 - a. The indoor fan shall be an assembly with a turbo fan direct driven by a single motor.
 - b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - c. The indoor fan shall be capable of three (3) speed settings, Low, Mid, and High.
 - d. The indoor unit shall have an adjustable air outlet system offering 4-way airflow, 3-way airflow, or 2-way airflow.
 - e. The indoor unit vanes shall have 5 fixed positions and a swing feature that shall be capable of automatically swinging the vanes up and down for uniform air distribution.
 - f. Grille shall include an optional "3D i-see" sensor, or equal, to work in conjunction with indoor unit control sequence to prevent unnecessary cooling or heating in unoccupied areas of the zone without decreasing comfort levels. Sensor must detect occupancy (not simply motion) and location of occupants by measuring size & temperature of objects within a 39 foot detecting diameter (based on 8.8 foot mounting height) with 1,856 or more measuring points.
4. Filter:
 - a. Return air shall be filtered by means of a long-life washable filter.
5. Coil:
 - a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
 - b. The coils shall be pressure tested at the factory.
 - c. The unit shall be provided with an integral condensate lift mechanism that will be able to raise drain water 19-3/4 inches above the condensate pan.
6. Electrical:
 - a. The unit electrical power shall be 208/230 volts, 1-phase, 60 hertz.
 - b. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
7. Controls:
 - a. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
 - b. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
 - c. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
 - d. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.
 - e. A factory-installed drain pan sensor shall provide protection against drain pan overflow by sensing a high condensate level in the drain pan. Should this occur, the control shuts down the indoor unit before an overflow can occur. A thermistor error code will be produced should the sensor activate indicating a fault which must be resolved before the unit re-starts.

2.4 CONTROLS

A. General

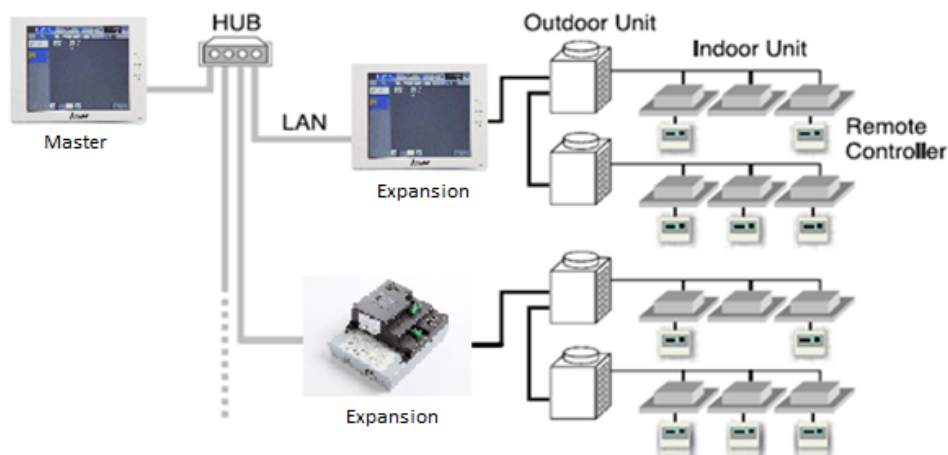
1. The control system shall consist of a low voltage communication network and a web-based interface. The controls system shall gather data and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.
2. Furnish energy conservation features such as optimal start, request-based logic, and demand level adjustment of overall system capacity as specified in the sequence.
3. System shall be capable of email generation for remote alarm annunciation.

B. Electrical Characteristics

1. General:
 - a. Controller power and communications shall be via a common non-polar communications bus and shall operate at 30VDC.
2. Wiring:
 - a. Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
 - b. Control wiring for centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to the system controllers (centralized controllers and/or integrated web based interface), to the power supply.
3. Wiring type:
 - a. Wiring shall be 2-conductor (16 AWG), twisted, stranded, shielded wire as defined by the Diamond System Builder output.
 - b. Network wiring shall be CAT-5 with RJ-45 connection.

2.5 CITY MULTI CONTROLS NETWORK

- A. The CITY MULTI Controls Network (CMCN) consists of remote controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The CITY MULTI Controls Network shall support operation monitoring, scheduling, occupancy, error email distribution, personal web browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using either LonWorks® or BACnet® interfaces. The below figure illustrates a sample CMCN System Configuration.



2.6 CMCN: REMOTE CONTROLLERS

- A. Touch MA Remote Controller:

1. The Backlit Touch MA Remote Controller shall be capable of controlling up to 16 indoor units (defined as 1 group).
2. The Backlit Touch MA Remote Controller shall only be the only controller in the group.

Touch MA Remote Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation for a single group	Each Group	Each Group
Operation Mode	Switches between Cool/Drying/Auto/Fan/Heat/Setback. Operation modes vary depending on the air conditioner unit. Auto and Setback mode are available for the R2/WR2-Series only.	Each Group	Each Group
Temp. Setting	Sets the temperature from 32°F – 104°F depending on operation mode and indoor unit. Separate COOL and HEAT mode set points available depending on central controller and connected mechanical equipment.	Each Group	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Group	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *1: Centrally Controlled is displayed on the remote controller for prohibited functions.	N/A	Each Unit *1
Display Indoor Unit Intake Temp	Measures and displays the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Display Backlight	Pressing the screen lights up a backlight. The light automatically turns off after a certain period of time. (The brightness settings can be selected from Bright, Dark, and Light off.)	N/A	Each Unit
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed.	N/A	Each Unit
Test Run	Operates air conditioner units in test run mode. *2 The display for test run mode will be the same as for normal start/stop (does not display “test run”).	Each Group	Each Group *2
Ventilation Equipment	Up to 16 indoor units can be connected to an interlocked system that has one LOSSNAY unit.	Each Group	N/A
Set Temp. Range Limit	Set temperature range limit for cooling, heating, or auto mode.	Each Group	Each Group
Display Color Change	Controller can allow for the user to change the color of the text and/or background.	Each Controller	N/A

2.7 CENTRALIZED CONTROLLER (WEB-ENABLED)

A. Master Centralized Controller:

1. The Master Centralized Controller shall be capable of controlling a maximum of two hundred (200) indoor units across multiple CITY MULTI outdoor units with the use of three expansion controllers. The Master Centralized Controller shall be approximately 11-5/32" x 7-55/64" x 2-17/32" in size and shall be powered with an integrated 100-240 VAC power supply. The Master Centralized Controller shall support system configuration, daily/weekly scheduling, monitoring of operation status, night setback settings, free contact interlock configuration and malfunction monitoring. When being used alone without the expansion controllers, the Master Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a collection of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic set of operation controls for the Master Centralized Controller shall include on/off, operation mode selection (cool, heat, auto (R2/WR2-Series only), dry, setback (R2/WR2-Series only) and fan), temperature setting, fan speed setting, and airflow direction setting. Since the master provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the Master Centralized Controller shall allow the user to define both daily and weekly schedules (up to 24 scheduled events per day) with operations consisting of ON/OFF, mode selection, temperature setting, air flow (vane) direction, fan speed, and permit/prohibit of remote controllers.

Master Centralized Controller			
Item	Description	Operation	Display
ON/OFF	Run and stop operation.	Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry/Auto/Fan/Heat. (Group of Lossnay unit: automatic ventilation/vent-heat/interchange/normal ventilation) Operation modes vary depending on the air conditioner unit. Auto mode is available for the R2/WR2-Series only.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature from 57°F – 87°F depending on operation mode and indoor unit.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Available fan speed settings depending on indoor unit.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction settings vary depending on the indoor unit model. *1. Louver cannot be set.	*1 Each Block, Group or Collective	Each Group
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized start setting is also available. *1. The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can scheduled per day, including ON/OFF, Mode, Temperature Setting, Air Direction, Fan Speed and Operation Prohibition.	*2 Each Block, Group or Collective	Each Group

Master Centralized Controller			
Item	Description	Operation	Display
	Five types of weekly schedule (seasonal) can be set. Settable items depend on the functions that a given air conditioning unit supports.		
Optimized Start	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3. Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Room Temp	Displays the room temperature of the group. Space temperature displayed on the indoor unit icon on the touch screen interface.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed. *4 When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection.	N/A	*4 Each Unit or Collective
Outdoor Unit Status	Compressor capacity percentage and system pressure (high and low) pressure (excludes S-Series)	Each ODU	Each ODU
Connected Unit Information	MNET addresses of all connected systems	Each IDU, ODU and BC	Each IDU, ODU and BC
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between "Hi", "Low" and "Stop". When setting a group of only free plan LOSSNAY units, you can switch between "Normal ventilation", "Interchange ventilation" and "Automatic ventilation".	Each Group	Each Group
Multiple Language	Other than English, the following languages can be selected: Spanish, French, Japanese, Dutch,	N/A	Collective

Master Centralized Controller			
Item	Description	Operation	Display
	Italian, Russian, Chinese, and Portuguese.		
External Input / Output	By using accessory cables you can set and monitor the following: Input: By level: "Batch start/stop", "Batch emergency stop" By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" *5. Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective

1. All Master Centralized Controllers shall be equipped with two RJ-45 Ethernet ports to support interconnection with a network PC via a closed/direct Local Area Network (LAN) or to a network switch for IP communication to up to three expansion controllers for display of up to two hundred (200) indoor units on the main master centralized controller interface.
2. The Master Centralized Controller shall be capable of performing initial settings via the high-resolution, backlit, color touch panel on the controller or via a PC browser using the initial settings.
3. Standard software functions shall be available so that the building manager can securely log into each master centralized controller via the PC's web browser to support operation monitoring, scheduling, error email, interlocking and online maintenance diagnostics. Additional optional software functions of personal browser for PCs and MACs and Energy shall be available but are not included. The Energy Apportionment function shall require a LIC-Charge software license

B. Expansion Controller:

1. The Expansion Controller shall serve as a standalone centralized controller or as an expansion module to the Master Centralized Controller for the purpose of adding up to 50 indoor units to either the main touch screen interface of the master centralized controller. Up to three (3) expansion controllers can be connected to the master via a local IP network (and their IP addresses assigned on the master) to the master to allow for up to two hundred (200) indoor units to be monitored and controlled from the master interface.
2. The expansion controllers have all of the same capabilities to monitor and control their associated indoor units as the features specified above. Even when connected to the master and configured to display their units on the main controller, the individual indoor units connected to the expansion can still be monitored and controlled from the interface of the expansion. The last command entered will take precedence, whether at the wall controller, the expansion or the master Centralized Controller.
3. Non Touch Screen, Networked Centralized Controller:

2.8 GRAPHICAL USER INTERFACE

- A.** The Graphical User Interface (Integrated Centralized Control Web) shall require a field supplied PC or Tablet.

- B. The Integrated Centralized Control Web System (ICCW) interface shall enable the user to control multiple networked central controllers and shall provide additional functions such as energy apportionment from a single network PC configured with the Charge Calculation Tool. The ICCW shall be capable of controlling up to forty networked Centralized Controllers with a maximum of 2,000 indoor units across multiple CITY MULTI outdoor units. The ICCW shall be required if the user wants to simultaneously control more than 1 Centralized Controllers from a single PC or tablet using a single web browser session. Licensing per function, per Centralized Controller shall be required for the ICCW. Optional software features shall be available through the ICCW including energy apportionment and personalized web. These optional software features shall require the ICCW, advance purchase from the customer, and licensing from ICCW.

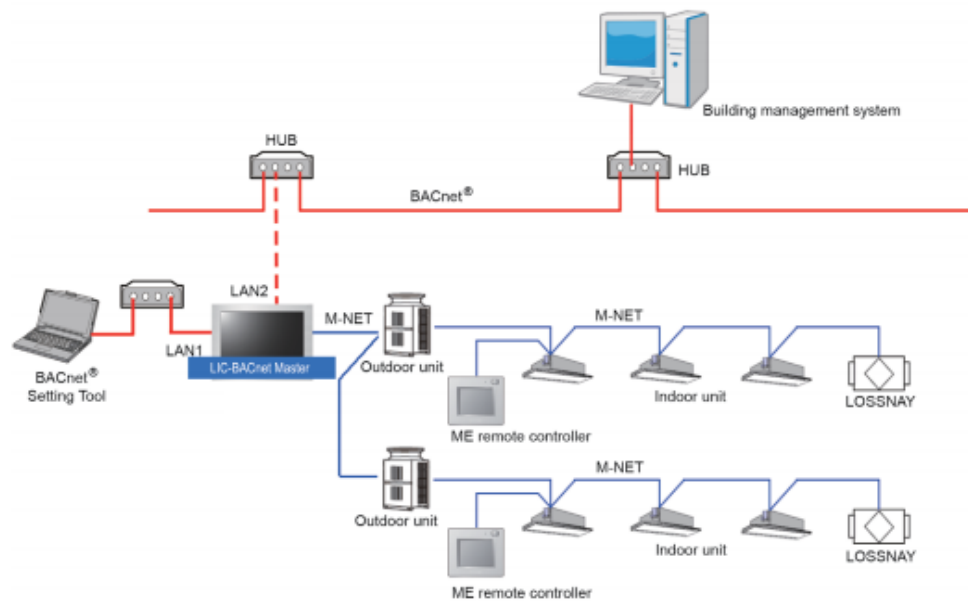
ICCW (Integrated System Software)	
Item	Details
ON/OFF	The units can turn ON and OFF for all floors or in a block, floor, or group of units.
Operation Modes	The operation mode can be switched between COOL, DRY, FAN, AUTO, and HEAT for all floors or in a block, floor, or group of units.
Temperature Setting	Sets the temperature for a single group. Range of Temperature setting from 57°F – 87°F depending on operation mode and indoor unit model. Separate COOL and HEAT mode set points available depending on remote controller and connected mechanical equipment.
Fan Speed	The fan speed can be set to four stages for all floors or in a block, floor, or group of units.
Air Direction	The air direction can be set in four vertical directions or to swing for all floors or in block, floor, or group of units. (The selectable air direction differs according to the model.)
Interlocked Unit ON/OFF LOSSNAY	If there is an interlocked unit (LOSSNAY), then the unit can be turned ON (strong/weak) or OFF for all floors or in a block, floor, or group of units. (Note that the ventilation mode cannot be selected for interlocked units.)
Local Operation Prohibit	The items for which operation with the local remote controller are to be prohibited can be selected for all floors or in a block, floor, or group of units. (The items that can be prohibited are ON/OFF, operation mode, set temperature and filter sign reset.)
Annual / Weekly Schedule	The annual/weekly schedule function can be used by registering the license. Two settings, such as seasonal settings for summer and winter, can be saved.
Power Rate Apportionment Charging	A watt-hour meter (WHM) with kWH pulse output is connected to calculate the air conditioning charges based on the amount each tenant's air-conditioner has operated. Five charging rates can be applied per day. ***OPTIONAL ENERGY APPORTIONMENT SOFTWARE (LIC-CHARGE) and PI Controller (PAC-Y60MCA) REQUIRED
History	Up to 3,000 items for the error history and up to 10,000 items for operation history can be saved. Each history file can be output as a daily report or monthly report in CSV format. (The operation history consists only of the operations carried out with the ICCW and is limited to some limited operation items.)
Operation Time Monitor	The cumulative operation time of each indoor unit can be viewed or output as a CSV format file. (This function is valid only when the charging function license is registered.)
Filter Sign Display Mask	The filter sign display at the remote controllers can be disabled.
Set Temperature	The set temperature lower limit can be set for cooling and the upper limit for heating. (ME remote controller required)

ICCW (Integrated System Software)	
Item	Details
Limit	

2.9 CMCN SYSTEM CONFIGURATION

A. CMCN: SYSTEM INTEGRATION

1. BACnet® Integration:
 - a. The Mitsubishi Electric Cooling & Heating BACnet® hardware, which is built into all networked central controllers, shall be compliant with BACnet® Protocol (ASHRAE Std 135) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support BACnet Broadcast Management (BBMD). The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address.
2. Licenses:
 - a. LIC-BACnet Master: Master Controller license for Master Centralized Controller and Non Touch Screen, Networked Centralized Controller.
 - b. LIC-BACnet Expansion: Expansion Controller license for Expansion Controller and Non Touch Screen, Networked Centralized Controller.
3. LIC-BACnet Specifications:
 - a. Control up to 50 groups
 - b. 1 to 16 indoor units can be collectively controlled in a group
 - c. Supports dual set point functionality (connected model dependant)
 - d. BTL Compliant
 - e. BACnet communication specifications are based on ASHRAE Std 135.
4. PC Requirements:
 - a. CPU: 1GHz or higher
 - b. Memory: 1GB or more
 - c. HDD Space: 100 MB or more
 - d. Screen Resolution: 1024 x 768 or higher
 - e. OS: Microsoft Windows 7 32-bit/64-bit, Microsoft 8.1 32-bit/64-bit. Not compatible with Windows Vista
 - f. Execution Environment: Microsoft .NET Framework 4.5 or later
 - g. Others: Pointing device such as a mouse, internet connection (required when installing a .NET Framework)
5. LIC-BACnet – System Example



a. BACnet Point List

<u>Object List</u>
On Off Setup
On Off State, Number of ON/OFF, Cumulative operation time
Alarm Signal (4-digit error code)
Error Code
Operational Mode Setup
Operational Mode State
Fan Speed Setup
Fan Speed State
Room Temp [Water Temp]
Set Temp [Set Water Temp]
Set Temp Cool
Set Temp Heat
Set Temp Auto
Filter Sign [Circulating Water Exchange Sign]
Filter Sign Reset [Circulating Water Exchange Sign Reset]

Prohibition On Off
Prohibition Mode
Prohibition Filter Sign Reset [Prohibition Circulating Water Exchange Sign Reset]
Prohibition Set Temperature
M-NET Communication State
System Forced Off
Air Direction Setup
Air Direction State
Set High Limit Setback Temp
Set Low Limit Setback Temp
Ventilation Mode Setup
Ventilation Mode State
Air To Water Mode Setup
System Alarm Signal (4-digit error code)
PI Controller Alarm Signal (4-digit error code)
Group Apportioned Electric Energy
Interlocked Units Apportioned Electric Energy
PI controller Electric Energy 1–4
Pulse Input Electric Energy 1–4
Group Apportionment Parameter
Interlocked Units Apportionment Parameter
Night Purge State
Thermo On Off State
Trend Log Room Temp
Trend Log Group Apportioned Electric Energy
Trend Log Interlocked Units Apportioned Electric Energy
Trend Log PI controller Electric Energy 1–4

Trend Log Pulse Input Electric Energy 1–4
Trend Log Group Apportionment Parameter
Trend Log Interlocked Units Apportionment Parameter

2.10 LEV KIT

A. General:

1. The PAC-AH001-1 Linear Expansion Valve Kit shall be a dedicated custom package to allow the integration of CITYMULTI VRF with custom direction expansion coils selected in accordance with factory specifications. The package comprises of the following components:
 - a. PAC-AH001-1 Controller.
 - b. NEMA 1 Rated Control Panel Enclosure.
 - c. Linear Expansion Valves:
 - 1) PAC-LV24AC-1 (2 ton nominal).
 - 2) PAC-LV48AC-1 (4 ton nominal).
 - 3) PAC-LV60AC-1 (5 ton nominal)
 - 4) PAC-LV96AC-1 (8 ton nominal).
 - 5) PAC-LV120AC-1 (10 ton nominal).
 - d. Thermistors TH-21/22/23/24 (return air, liquid line, suction line, supply air)
 - e. Custom DX Coil (by others).
2. Linear Expansion Valves - The PAC-AH001-1 Linear Expansion Valve Kit shall be provided with Mitsubishi Electric Trane HVAC Linear expansion valves for installation in parallel in the field as per the following:
 - a. PAC-LV24AC-1 – Qty 1 of a 2 ton nominal LEV.
 - b. PAC-LV48AC-1 – Qty 1 of a 4 ton nominal LEV
 - c. PAC-LV60AC-1 – Qty 1 of a 5 ton nominal LEV.
 - d. PAC-LV96AC-1 – Qty 2 of a 4 ton nominal LEV (factory brazed assembly)
 - e. PAC-LV120AC-1 – Qty 2 of a 5 ton nominal LEV (factory brazed assembly).
3. Each Linear Expansion Valve shall be supplied with integrated power cable for termination at the PAC-AH001-1 control panel in the field.

B. Control Panel:

1. The PAC-AH001-1 control panel shall be NEMA-1 or equivalent rated for installation indoor or in a suitably rated enclosure. The control panel shall be installed in the field in close proximity to the custom direct expansion coil (up to 16') to facilitate the field wiring of control and power wiring. The PAC-AH001-1 control panel shall have the following input/output terminals to facilitate interlocks and communication with third party control systems:
 - a. ON/OFF Input (A1-A2).
 - b. Analog Input – Supply/Return Air Set-Point Control (B1-B2).
 - c. Damper Signal Output (D1-D2)
 - d. Error Signal Output (E1-E2)
 - e. Float Switch Input (FS1-FS2)
 - f. Heater Output Signal (H1-H2)
 - g. Operation Signal Output:
 - 1) Error Signal Output (OE).
 - 2) Operation Signal Heating (OH).
 - 3) Operation Signal Cooling (OC)
 - 4) Operation Signal Defrost (OD)
 - h. Three Speed Fan Signal Output.

C. Custom Coil

1. The PAC-AH001-1 Linear Expansion Controller shall be provided with a custom direct expansion coil selected and manufactured to Mitsubishi Electric Trane HVAC factory specifications. Each selection shall be application specific and must be selected to match strict factory specification criteria detailed in the LEV Control Box and Valve Assemblies Application Guide.

- D. Electrical:
 - 1. The unit electrical power shall be 208/230 volts, 1-phase, 60 Hertz. The system shall be capable of satisfactory operation within voltage limits of 187-228 volts (208V/60Hz) or 207-253 volts (230V/60Hz).
- E. Controls:
 - 1. This unit shall use controls provided by Mitsubishi Electric Trane HVAC to perform functions necessary to operate the system. Please refer to the controls section of the LEV Control Box and Valve Assemblies Application Guide for details on controllers and other control options.
 - 2. Alternately, the PAC-AH001-1 Linear Expansion Valve Controller can be controlled via third party control systems using the 0-10 VDC analog input function (B1-B2) along with the other control contact points detailed previously.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.
- B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.
- C. Notify Architect if conditions for installation are unsatisfactory.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
- C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
- D. Coordinate with installers of systems and equipment connecting to this system.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide manufacturer's field representative to inspect installation prior to startup.

3.4 SYSTEM STARTUP

- A. Provide manufacturer's field representative to perform system startup.
- B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
- C. Adjust equipment for proper operation within manufacturer's published tolerances.

3.5 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Clean exposed components of dirt, finger marks, and other disfigurements.

3.6 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - 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. 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.

3.7 PROTECTION

- A. Protect installed components from subsequent construction operations.
- B. Replace exposed components broken or otherwise damaged beyond repair.

END OF SECTION

SECTION 23 82 00
CONVECTION HEATING AND COOLING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Hydronic or steam finned tube radiation.
- B. Hydronic or steam cabinet unit heaters.
- C. Unit ventilators.

1.2 RELATED REQUIREMENTS

- A. Section 23 07 19 - HVAC Piping Insulation.
- B. Section 23 09 93 - Sequence of Operations for HVAC Controls.
- C. Section 23 21 13 - Hydronic Piping.
- D. Section 23 21 14 - Hydronic Specialties.

1.3 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); Current Edition.
- B. AHRI 350 (SI/I-P) - Sound Performance Rating of Non-Ducted Indoor Air-Conditioning and Heat Pump Equipment; 2025.
- C. AHRI 840 (I-P) - Performance Rating of Unit Ventilators; 2021.
- D. AHRI 841 (SI) - Performance Rating of Unit Ventilators; 2021.

1.4 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.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Indicate air coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
 - 3. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 4. Indicate mechanical and electrical service locations and requirements.

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

1.6 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.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer(s) shall provide whole unit parts and labor warranties that cover the unit(s) in continuation of the standard warranty for a period of 5 years from start-up. The warranty shall be provided by the manufacturer; third party insurance/warranty coverage is not acceptable.
- C. Blow-through unit ventilators are the basis of design. Draw-through unit ventilators shall be supplied with a face and bypass damper and a 5-year parts and labor warranty covering coil freeze-ups. The contractor shall submit a warranty letter with bid.

PART 2 PRODUCTS

2.1 HYDRONIC FINNED TUBE RADIATION

- A. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- B. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- C. Enclosures: 18 gauge, 0.0478 inch sheet steel up to 18 inches in height, 16 gauge, 0.0598 inch sheet steel over 18 inches in height or aluminum as detailed, with easily jointed components for wall to wall installation.
- D. Finish: Factory applied baked primer coat.
- E. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- F. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

2.2 HYDRONIC CABINET UNIT HEATERS

- A. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- B. Coils:
 - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
- C. 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.
- D. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.

- E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- F. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- G. Control: Factory wired, solid state, infinite speed control, located in cabinet.
- H. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.

2.3 UNIT VENTILATORS

- A. Manufacturers:
 - 1. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Performance Data and Safety Requirements:
 - 1. Unit capacities certified and tested in accordance with AHRI 840 (I-P) (AHRI 841 (SI)) and AHRI 350 (SI/I-P).
 - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for purpose indicated.
- C. Required Directory Listings: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI).
- D. Hydronic Coils:
 - 1. Copper tubes mechanically expanded or bonded into evenly spaced aluminum fins.
 - 2. Factory pressure tested, hydrostatically, to not less than 350 psi.
 - 3. Provide insulated drain pan under chilled water coils, to prevent sweating, with field convertible left or right hand drain connections.
- E. Refrigerant Coils:
 - 1. Provide factory installed thermal expansion valves, properly sized to accommodate the selected condensing unit.
 - 2. Factory proof and leak tested to ensure leak tight operation.
 - 3. Provide insulated drain pan, to prevent condensation, with field convertible left or right hand connections.
 - 4. Refrigerant access ports shall be factory-supplied on the high and low side for easy refrigerant pressure or temperature testing.
- F. Cabinet: 16 gauge, 0.0747 inch sheet steel on solid base pan with exposed edges rounded. Provide removable front panels with quick-acting, key-operated cam locks. Provide removable die-cast or fabricated steel discharge grilles. For units having cooling coils, insulate internal parts and surfaces exposed to conditioned air stream with moisture resistant insulation. All steel surfaces are cleaned, phosphatized, rinsed, and dried before application of final finish paint. The paint shall be applied by an electrostatic powder spray system. The minimum thickness of paint shall be 1.5 mil that results in an appliance-grade finish. Cabinet end pockets shall be a minimum of 12 inches wide to facilitate piping and service. If less than 12 inches, unit manufacturer shall provide an extended cabinet or piping enclosure.
 - 1. Floor-mounted units shall have an integral pipe tunnel for convenient crossover of piping or electrical wiring. The front surface shall consist of three removable panels for quick access.
 - 2. The unit discharge grille shall be of a double deflection type to throw air in two directions
 - 3. To prevent entry of small objects into the fan, draw-through units shall be provided with a discharge grille screen.
 - 4. Units shall have four adjustable leg levelers.
 - 5. End panels shall be factory-installed on the unit.
 - 6. Front panel shall be 14 gauge and insulated for acoustical attenuation.
- G. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- H. Fan Assembly and Motor:

1. A factory-mounted High-Medium-Low-Off switch shall control motor speed. Provide actual airflow data per specific coil option.
 2. For quick maintenance, the fan board assembly shall be a single, rigid assembly including fans, fan housing, bearing, and fan shaft. Fan assembly shall be easily removable through the front panel with two screws.
 3. Fan/coil arrangement shall be blow-through design to eliminate debris from falling into the spinning fan. This safety consideration helps prevent personal injury, noise, or equipment damage. The blow-through design shall protect the coil from freezing by placing the coil farther away from the inlet and mixing the room air and fresh air before it blows across the coil. The coil shall be placed near the discharge opening in order to attenuate fan noise.
 4. Motor: All motors shall be Brushless DC (BLDC)/Electronically Commutated Motors (ECM) factory programmed and run tested in assembled units.
 5. The motor controller shall be separate from the motor, mounted in a touch-safe control box for easy access with a built in integrated user interface and real language LED tachometer with continuous status display and integrated motor diagnostics.
 6. Motors shall have a soft ramp between speed changes to minimize the acoustical impact due to speed changes.
- I. Filters: Each unit shall be equipped with a single MERV 13 filter accessible through the removal of a single unit front panel.
- J. Fresh Air and Room Air Dampers:
1. The unit shall be equipped with a single-blade, mixing damper capable of varying the proportion of mixed air from 100 percent room air to 100 percent fresh air.
 2. Provide an ultra-low leak damper seal with stainless steel jamb seals. Leakage shall be less than 1 percent against 0.5 inches of external static pressure.
 3. Damper shall contain a continuous divider placed between the damper blades to separate the fresh air and room air compartments to prevent blow-through.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 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. Cabinet Unit Heaters:
 1. Install as indicated.
 2. Coordinate to ensure correct recess size for recessed units.
- E. Unit Ventilators:
 1. Locate as indicated, level and shim units, and anchor to structure.
 2. Coordinate exact location of wall louvers.
 3. Install shelving and auxiliary cabinetry.
 4. Provide wall trim pieces for continuous wall-to-wall installation.
- F. Units with Hydronic Coils:
 1. Provide with shut-off valve on supply piping and tamper-proof, balancing valve with memory stop on return piping.

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2. If not easily accessible, extend air vent to exterior surface of cabinet for ease of servicing.
3. Provide float operated automatic air vents with stop valve for cabinet unit heaters, fan coil units, and unit heaters.

G. Units with Cooling Coils: Connect drain pan to condensate drain.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Provide manufacturer's field representative to test, inspect, instruct, and observe.

3.4 CLEANING

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

3.5 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for closeout submittals.

3.6 PROTECTION

- A. Provide finished cabinet units with protective covers during the balance of construction.

END OF SECTION

SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. General requirements applicable to all components and systems included in Electric Work Prime Contract
- B. Products Installed but Not Furnished Under This Section
- C. Make all electrical connections to equipment shown on Drawings and furnished by other Prime Contractors. Obtain approved wiring diagrams and location drawings for roughing in and final connections from Prime Contractor furnishing equipment. Provide disconnect switches, push button stations, and similar components, required but not furnished with equipment as shown on Drawings.

1.2 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements:
- B. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.
- C. Section 01 78 00 - Closeout Submittals: Project record documents.

1.3 REFERENCES

- A. AIA American Institute of Architects
- B. AISC American Institute of Steel Construction
- C. ANSI American National Standards Institute
- D. ASTM American Society of Testing Materials
- E. IEEE Institute of Electric and Electronic Engineers
- F. IES Illuminating Engineering Society
- G. NBFU National Board of Fire Underwriters
- H. NEC National Electric Code
- I. NEMA National Electrical Manufacturers' Association
- J. NETA International Electrical Testing Association
- K. NFPA National Fire Protection Association
- L. UL Underwriters' Laboratories, Inc.

1.4 SYSTEM DESCRIPTIONS

- A. Design Requirements - Provide complete systems, properly tested, balanced, and ready for operation including necessary details, items and accessories although not expressly shown or specified, including (but not limited to):
 - 1. All wiring and conduit for work specified in Project Manual and shown on Drawings.
 - 2. All electrical devices and equipment for work specified in Project Manual and shown on Drawings.

- B. Systems included, but not limited to:
 - 1. Electrical Distribution
 - 2. Electrical Connections
 - 3. Electric Layouts: Arrange all panels, disconnect switches, enclosed breakers, equipment, raceways, and similar components neatly, orderly and symmetrically. Provide 3/4-inch plywood backboards for all surface mounted panels, disconnect switches, enclosed breakers, and similar equipment. Arrangements shown on Drawings are diagrammatic only; provide and adjust raceways, wiring, and other components as required.
 - 4. Power Interruptions and Scheduled Outages: Coordinate scheduling of all power interruptions and outages with Owner. EC shall confirm with Owner prior to interruption of power, which building systems are considered critical and must remain operational during the interruption. If a scheduled power outage is to extend beyond one standard workday, EC shall provide temporary power to operate critical building systems (including, but not limited to fire alarm system, security system, building access control system, and building energy management control system).

1.5 QUALITY ASSURANCE

- A. Codes and Standards: Comply with all applicable Federal, State and Local Building and Electrical Codes, Laws, Ordinances, and Regulations, and comply with all applicable NFPA, National Electrical Code and Utility Company requirements and regulations. Provide Underwriter's Laboratory Seal on all materials.
- B. Permits and Inspections: Obtain all approvals, tests, and inspections required by Architect, Engineer, Local Electrical Inspector, agent or agency specified in Project Manual, or National, State, or Local Codes and Ordinances.
- C. Schedule electrical inspection by a third party inspection agency, such as New York State Board of Fire Underwriters or equivalent, acceptable to the local authority having jurisdiction, and submit final inspection certificate to Architect.
- D. Furnish all materials and labor necessary for tests and pay all costs associated with tests and inspections.
- E. Conduct all tests under load for load balancing and where required by Codes, Regulations, Ordinances, or Technical Specification.
- F. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Take all reasonable precautions to store materials and products to protect finishes and not permit dust and dirt to penetrate equipment.
- B. Replace all equipment damaged beyond reasonable repair as required by Architect.
- C. Refinish any equipment with marks, stains, scratches, dents, etc., as required by Architect.

1.7 COORDINATION OF WORK

- A. New Construction
 - 1. Openings, Chases, Recesses, Sleeves, Lintels and Bucks (required for admission of Electric Work Prime Contract systems and components): Coordinate requirements with General Work Prime Contractor for inclusion in General Work Prime Contract. Furnish all necessary information (e.g. locations and sizes) to General Work Prime Contractor in ample time for installation of systems and components included in Electric Work Prime Contract.

2. Anchor Bolts: Deliver to General Work Prime Contractor all anchor bolts required for Electric Work Prime Contract construction that are to be installed in construction included in General Work Prime Contract.
 3. Locate settings, check locations as installation in General Work Prime Contract progresses, and provide templates or holding fixtures as required to maintain proper accuracy.
- B. Existing Construction: Unless otherwise specified, employ General Work Prime Contractor for all cutting, patching, repairing and replacing of general work required for installation of systems and components included in Electric Work Prime Contract. Secure approval before cutting.
1. Anchor Bolts: Deliver to General Work Prime Contractor all anchor bolts required for Electric Work Prime Contract construction that are to be installed in construction included in General Work Prime Contract. Provide templates or holding fixtures as required to maintain proper accuracy.
 2. Rough Openings in Roofs: Refer to Section 01 70 00 - Execution and Closeout Requirements.

1.8 ALTERATION PROCEDURES

- A. In locations where existing non-TCLP compliant fluorescent lamps are to be removed, all removals and disposal shall be in strict accordance with Section 01 35 17 - Alteration Project Procedures, and Section 01 74 19 - Construction Waste Management and Disposal; Landfill diversion proposals; Waste Disposal Reports shall be done as part of Electrical Work Prime Contract.
- B. In locations where existing devices are indicated to be disconnected and removed and existing circuit is not scheduled to be reused:
1. Remove circuit conductors back to source.
 2. Modify panel directory for that circuit.
 3. Remove all existing exposed and accessible conduit
 4. Provide blank cover plate over existing recessed junction boxes or back boxes. Paint cover plates in finished areas to match existing room finish.
 5. Patch and paint existing walls where disturbed by the electrical demolition. Refer to Section 01 35 17 - Alteration Project Procedures for additional requirements for patching and painting.
- C. In locations where existing devices are to remain in place, ensure circuits feeding such devices remain operational. Modify existing circuits as required to allow new construction to occur and to maintain all necessary circuitry to existing devices.
- D. In locations where entire existing system is being removed or modified:
1. Refer to individual system specification sections for Documentation and Testing Requirements prior to any alteration work on any system.
 2. Take all necessary measures to ensure that down time will not compromise safety
 3. Notify Owner, Architect and all other Prime Contractors not less than 2 weeks prior to interruptions in service.
 4. Coordinate work schedule to minimize duration of system outage during hours when building is occupied.
 5. Refer to Section 01 30 00 - Administrative Requirements for additional information and requirements.

1.9 SUBMITTALS

- A. Comply with requirements of Section 01 30 00 - Submittal Procedures and as modified below. Refer to submittal listing in each section for specific items required.
- B. Factory-Finished Surfaces: On all submittals, indicate standard factory color. Where more than one color is available, selection made by Architect from manufacturer's full range of colors.
- C. Contract Closeout Submittals: Comply with requirements of Section 01 78 00, including submission of operating and maintenance instructions as item in "Electric Work Instructions" manual described in that section.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 CUTTING AND PATCHING

- A. Furnish and install all sleeves, inserts, panels, raceways, boxes, etc., ahead of general construction work and maintain Contractor personnel at Site during installation of general construction work to be responsible for and to maintain these items in position.
- B. Unless otherwise noted elsewhere in Contract Documents, bear expense of all cutting, patching, repairing or replacing of work of other trades made necessary by any fault, error or tardiness on part of Electrical Work Prime Contract or damage done by Electric Work Prime Contract. Employ and pay Prime Contractor whose work is involved.
- C. Do not cut waterproofed floors or walls for admission of any equipment or materials and do not pierce any structural members without written permission.

3.2 DEMONSTRATION OF COMPLETE ELECTRICAL SYSTEMS

- A. Thoroughly demonstrate and instruct Owner's designated representative in care and operation of all electrical systems and equipment furnished and installed in Electric Work Prime Contract.
- B. System Operator: Maintain competent operator at building for at least 2 days in 2 consecutive weeks after Owner takes occupancy of major parts of building to operate systems and equipment in presence of Owner's representative.
- C. Factory Representative: In addition to demonstration and instruction specified above, provide technically qualified factory representatives from manufacturers of major equipment, to train Owner's representatives in care and operation of applicable products as specified in applicable technical sections of Division 26.
- D. Coordinate and schedule time and place of all training through the Architect at the Owner's convenience.
- E. Submit letters attesting to satisfactory completion of all instructions, including date of completion of instruction, names of persons in attendance and signature of Owner's authorized representative
- F. Architect's representative must be present when Owner's representatives participate in instruction.
- G. The following equipment and systems are included:
 - 1. Emergency generator
 - 2. Lighting dimming systems
 - 3. Fire alarm system

3.3 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Provide full inspection of exposed finishes.
- C. Remove burrs, dirt, and construction debris.
- D. Repair damaged surfaces including chips, scratches, and abrasions. Damp Rag clean all electrical equipment, panels, boxes, and accessories.

END OF SECTION

SECTION 26 05 05
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical demolition.

1.2 RELATED REQUIREMENTS

- A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Architect before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.2 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove abandoned panelboards and distribution equipment.
- F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- H. Repair adjacent construction and finishes damaged during demolition and extension work.
- I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
- J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.4 CLEANING AND REPAIR

- A. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.
- B. Clean and repair existing materials and equipment that remain or that are to be reused.
- C. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Service entrance cable.
- C. Metal-clad cable.
- D. Wire and cable for 600 volts and less.
- E. Wiring connectors.
- F. Electrical tape.
- G. Heat shrink tubing.
- H. Oxide inhibiting compound.
- I. Wire pulling lubricant.
- J. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 05 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 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. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).
- C. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2023.
- D. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).
- E. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).
- F. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.

- G. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.
- H. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- I. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.
- J. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.
- K. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- N. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- O. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.
- P. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- Q. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- R. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- S. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- T. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.
- U. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.
- D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.6 QUALITY ASSURANCE

- A. Comply with all requirements of the Energy Conservation Construction Code in the State of New York, including but not limited to US Department of Energy, IECC 2018, and ASHRAE 90.1, including all updates, revisions and amendments.
- B. Comply with requirements of NFPA 70.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted.
- D. Concealed Dry Interior Locations: Use only building wire with Type THHN/THWN insulation in raceway or metal clad cable.
- E. Exposed Dry Interior Locations: Use only building wire with Type THHN/THWN insulation in raceway.
- F. Above Accessible Ceilings: Use only building wire with Type THHN/THWN insulation in raceway or metal clad cable.
- G. Wet or Damp Interior Locations: Use only building wire with Type THHN/THWN insulation in raceway.
- H. Exterior Locations: Use only building wire with Type THHN/THWN insulation in raceway.
- I. Underground Installations: Use only building wire with Type THHN/THWN insulation in raceway.
- J. Use solid conductors for all 12 AWG circuits. Use stranded conductors only for 10 AWG and larger.
- K. Use conductor not smaller than 16 AWG for control circuits.
- L. Use 10 AWG stranded conductors for 20 ampere, 120 volt branch circuits longer than 75 feet.
- M. Use 10 AWG stranded conductors for 20 ampere, 277 volt branch circuits longer than 150 feet.

2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Provide new conductors and cables manufactured not more than one year prior to installation.
- D. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
- E. Comply with NEMA WC 70.
- F. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
- G. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.
- H. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.
- I. Conductor Material:
 - 1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
 - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
 - 3. Tinned Copper Conductors: Comply with ASTM B33.
- J. Minimum Conductor Size:
 - 1. Branch Circuits: 12 AWG.
 - a. Exceptions:
 - 1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
 - 2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
 - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
- K. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- L. Conductor Color Coding:
 - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
 - 2. Color Coding Method: Integrally colored insulation.
 - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
 - 3. Color Code:
 - a. 480Y/277 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Brown.
 - 2) Phase B: Orange.
 - 3) Phase C: Yellow.
 - 4) Neutral/Grounded: Gray.
 - b. 208Y/120 V, 3 Phase, 4 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - 4) Neutral/Grounded: White.
 - c. 240/120 V, 1 Phase, 3 Wire System:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Neutral/Grounded: White.
 - d. Equipment Ground, All Systems: Green.

2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:

1. Copper Building Wire:
 - a. Cerro Wire LLC: www.cerrowire.com/#sle.
 - b. Encore Wire Corporation: www.encorewire.com/#sle.
 - c. General Cable Technologies Corporation: www.generalcable.com/#sle.
 - d. Industrial Wire & Cable, Inc: www.iewc.com.
 - e. Southwire Company: www.southwire.com/#sle.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Description: Single conductor insulated wire.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation:
 1. Copper Building Wire: Type THHN/THWN.

2.4 SERVICE ENTRANCE CABLE

- A. Manufacturers:
 1. Copper Service Entrance Cable:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Service Entrance Cable for Above-Ground Use: NFPA 70, Type SE multiple-conductor cable listed and labeled as complying with UL 854, Style R.
- C. Service Entrance Cable for Underground Use: NFPA 70, Type USE single-conductor cable listed and labeled as complying with UL 854, Type USE-2 and with UL 44 Type RHH/RHW-2.
- D. Conductor Stranding: Stranded.
- E. Insulation Voltage Rating: 600 V.

2.5 METAL-CLAD CABLE

- A. Manufacturers:
 1. AFC Cable Systems Inc: www.afcweb.com/#sle.
 2. Encore Wire Corporation: www.encorewire.com/#sle.
 3. Southwire Company: www.southwire.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
- C. Insulation Voltage Rating: 600 V.
- D. Insulation: Type THHN or THHN/THWN.
- E. Provide dedicated neutral conductor for each phase conductor.
- F. Grounding: Full-size integral equipment grounding conductor.
- G. Armor: Steel, interlocked tape.
- H. Provide PVC jacket applied over cable armor for exterior installations, or where indicated or required for environment of installed location.

2.6 WIRING CONNECTORS

- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
- B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

- C. Wiring Connectors for Splices and Taps:
 - 1. Copper Conductors Size 8 AWG and Smaller: Use twist-on insulated spring connectors.
 - 2. Copper Conductors Size 6 AWG and Larger: Use mechanical connectors; split bolt type.
 - a. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- D. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- E. Wiring Connectors for Terminations:
 - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
 - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
 - 3. Copper Conductors 6 AWG and larger: Use mechanical connectors where connectors are required.
 - 4. Stranded Conductors: Use crimped terminals for connections to terminal screws.
- F. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- G. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- H. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- I. Mechanical Connectors: Provide bolted type or set-screw type.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- J. Compression Connectors: Provide circumferential type crimp configuration.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- K. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
 - 1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.7 ACCESSORIES

- A. Electrical Tape:
 - 1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.

3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
 5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.
 6. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Wire Pulling Lubricant:
1. Manufacturers:
 - a. 3M: www.3m.com/#sle.
 - b. Ideal Industries, Inc: www.idealindustries.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Listed and labeled as complying with UL 267.
 3. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
 4. Suitable for use at installation temperature.
- E. Cable Ties: Material and tensile strength rating suitable for application.
1. Manufacturers:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as indicated.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Circuiting Requirements:
 - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
 - 2. When circuit destination is indicated without specific routing, determine exact routing required.
 - 3. Include circuit lengths required to install connected devices within 10 ft of location indicated.
 - 4. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
 - 5. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are indicated as separate, combining them together in a single raceway is permitted, under the following conditions:
 - a. Provide no more than six current-carrying conductors in a single raceway. Dedicated neutral conductors are considered current-carrying conductors.
 - b. Increase size of conductors as required to account for ampacity derating.
 - c. Size raceways, boxes, etc. to accommodate conductors.
 - 6. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.
 - 7. Provide oversized neutral/grounded conductors where indicated and as specified below.
 - a. Provide 200 percent rated neutral for feeders fed from K-rated transformers.
 - b. Provide 200 percent rated neutral for feeders serving panelboards with 200 percent rated neutral bus.
- B. Install products in accordance with manufacturer's instructions.
- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install metal-clad cable (Type MC) in accordance with NECA 120.
- E. Installation in Raceway:
 - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
 - 2. Pull all conductors and cables together into raceway at same time.
 - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
 - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- F. Exposed Cable Installation (only where specifically permitted):
 - 1. Route cables parallel or perpendicular to building structural members and surfaces.
 - 2. Protect cables from physical damage.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
 - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
 - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- I. Terminate cables using suitable fittings.
 - 1. Metal-Clad Cable (Type MC):
 - a. Use listed fittings.
 - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

- L. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
- M. Make wiring connections using specified wiring connectors.
 - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
 - 2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
 - 3. Do not remove conductor strands to facilitate insertion into connector.
 - 4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminants. Do not use wire brush on plated connector surfaces.
 - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
 - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- N. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
 - 1. Dry Locations: Use electrical tape.
 - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
 - 2. Damp Locations: Use insulating covers specifically designed for the connectors.
 - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
 - 3. Wet Locations: Use heat shrink tubing.
- O. Insulate ends of spare conductors using vinyl insulating electrical tape.
- P. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
- Q. Identify conductors and cables in accordance with Section 26 05 53. Identify each conductor with its circuit number or other designation indicated.
- R. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- S. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is only required for services and feeders. The resistance test for parallel conductors listed as optional is not required.
- D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground rod electrodes.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
- B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings; 2022.
- C. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify exact locations of underground metal water service pipe entrances to building.
 - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
 - 3. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
- C. Project Record Documents: Record actual locations of grounding electrode system components and connections.

- D. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Existing Work: Where existing grounding and bonding system components are indicated to be reused, they may be reused only where they are free from corrosion, integrity and continuity are verified, and where acceptable to the authority having jurisdiction.
- B. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- C. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- D. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- E. Grounding System Resistance:
 - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
 - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
- F. Grounding Electrode System:
 - 1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
 - a. Provide continuous grounding electrode conductors without splice or joint.
 - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
 - 2. Metal Underground Water Pipe(s):
 - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
 - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
 - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
 - 3. Concrete-Encased Electrode:
 - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of steel reinforcing bars embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

4. Ground Ring:
 - a. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
 - b. Provide connection from ground ring conductor to:
 - 1) Perimeter columns of metal building frame.
 - 2) Ground rod electrodes located at service entrance.
 5. Ground Rod Electrode(s):
 - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
 - b. Space electrodes not less than 10 feet from each other and any other ground electrode.
 - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
 6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.
- G. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
 2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
 3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
 4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
 5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
 6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
 7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
 - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
 - b. Metal gas piping.
 8. Provide bonding for interior metal air ducts.
 9. Provide bonding for metal building frame.
 10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
 11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.

2.2 GROUNDING AND BONDING COMPONENTS

- A. General Requirements:
1. Provide products listed, classified, and labeled as suitable for the purpose intended.
 2. Provide products listed and labeled as complying with UL 467 where applicable.
- B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 05 26:
1. Use insulated copper conductors unless otherwise indicated.
 - a. Exceptions:
 - 1) Use bare copper conductors where installed underground in direct contact with earth.
 - 2) Use bare copper conductors where directly encased in concrete (not in raceway).
 2. Wire: Stranded Copper.
- C. Connectors for Grounding and Bonding:

1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
 2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
 3. Unless otherwise indicated, use bronze mechanical connectors for accessible connections.
 - a. Exceptions:
 - 1) Use exothermic welded connections for connections to metal building frame.
 4. Manufacturers - Mechanical and Compression Connectors:
 - a. Burndy LLC: www.burndy.com/#sle.
 - b. Copperweld: www.copperweld.com.
 - c. Erico International: www.erico.com.
 - d. O-Z Gedney: www.emerson.com.
 - e. Thomas & Betts Corporation: www.tnb.com/#sle.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
 5. Manufacturers - Exothermic Welded Connections:
 - a. Copperweld: www.copperweld.com.
 - b. O-Z Gedney: www.emerson.com.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
 2. Material: Copper.
 3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.
 4. Manufacturers:
 - a. Copperweld: www.copperweld.com.
 - b. Thomas & Betts
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as indicated.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70.
 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
- D. Make grounding and bonding connections using specified connectors.
 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.

3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13.
- D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
- E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
- F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 33.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.
- C. Section 26 05 33.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.
- D. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
 - 2. Coordinate work to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
 - 4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
 - 5. Notify Architect of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel/strut framing systems, nonpenetrating rooftop supports, and post-installed concrete/masonry anchors.
- C. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
- D. Installer's qualification statement.
- 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.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. NFPA 70.
 - b. Requirements of authorities having jurisdiction.
 - 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.
 - 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 - 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 - 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
 - 1. Manufacturers:

- a. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Metal Channel/Strut Framing Systems:
 - 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 2. Comply with MFMA-4.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use zinc-plated 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 wide by 13/16 inch high.
- E. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - e. Outlet Boxes: 1/4-inch diameter.
 - f. Luminaires: 1/4-inch diameter.
- F. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
 - 2. Concrete: Use expansion anchors or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam clamps or machine bolts.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood: Use wood screws.
 - 9. Powder-actuated fasteners are permitted only as follows:
 - a. Use only threaded studs; do not use pins.
 - 10. Hammer-driven anchors and fasteners are not permitted.
 - 11. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
 - 12. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

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

- B. Install hangers and supports in accordance with NECA 1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - a. Minimum standoff: 1 inch.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
 - 5. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
 - 6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
 - 7. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- J. Secure fasteners in accordance with manufacturer's recommended torque settings.
- K. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 26 05 33.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Galvanized steel rigid metal conduit (RMC).
- B. Galvanized steel intermediate metal conduit (IMC).
- C. Liquidtight flexible metal conduit (LFMC).
- D. Galvanized steel electrical metallic tubing (EMT).
- E. Rigid polyvinyl chloride (PVC) conduit.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.
- B. Section 07 84 00 - Firestopping.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- F. Section 26 05 33.16 - Boxes for Electrical Systems.
- G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.
- B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.
- C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.
- F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- G. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Metal Conduit and Intermediate Metal Conduit; 2018.
- H. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- I. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- K. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

- L. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.
- M. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.
- N. UL 360 - Liquid-Tight Flexible Metal Conduit; Current Edition, Including All Revisions.
- O. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.
- P. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.
- Q. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.
- R. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.
- S. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel; Current Edition, Including All Revisions.
- T. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.
- C. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2-inch (53 mm) trade size and larger.

1.6 QUALITY ASSURANCE

- A. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- B. Work shall be inspected by a local Authority Having Jurisdiction (AHJ). Contractor shall provide certificate of inspection prior to final payment request.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.
- C. Underground:
 - 1. Under Slab on Grade: Use galvanized steel rigid metal conduit.
 - 2. Exterior, Direct-Buried: Use rigid PVC conduit.
 - 3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl chloride (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or schedule 80 rigid PVC conduit where emerging from underground.
 - 5. Where rigid polyvinyl (PVC) conduit larger than 2-inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit (RMC) elbows, stainless steel rigid metal conduit (RMC) elbows, galvanized steel intermediate metal conduit (IMC) elbows, stainless steel intermediate metal conduit (IMC) elbows, PVC-coated galvanized steel rigid metal conduit (RMC) elbows, or concrete-encased PVC elbows for bends.
- D. Embedded Within Concrete:
 - 1. Within Slab on Grade: Use rigid PVC conduit.
 - 2. Within Slab Above Ground: Use rigid PVC conduit.
 - 3. Within Concrete Walls Above Ground: Use rigid PVC conduit.
 - 4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), or galvanized steel electrical metallic tubing (EMT) where emerging from concrete.
- E. Concealed Within Masonry Walls: Use electrical metallic tubing (EMT).
- F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).
- G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).
- H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).
- I. Exposed, Interior, Not Subject to Physical Damage: Use electrical metallic tubing (EMT).
- J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
 - 1. Locations subject to physical damage include, but are not limited to:
 - a. Where exposed below 8 feet, except within electrical and communication rooms or closets.
- K. Exposed, Exterior: Use galvanized steel rigid metal conduit.
- L. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
 - 1. Maximum Length: 6 feet.
- M. Flexible Connections to Vibrating Equipment:
 - 1. Dry Locations: Use flexible metal conduit (FMC).
 - 2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit (LFMC).
 - 3. Maximum Length: 6 feet unless otherwise indicated.

CONDUIT FOR ELECTRICAL SYSTEMS

4. Vibrating equipment includes, but is not limited to:
 - a. Transformers.
 - b. Motors.
- N. Fished in Existing Walls, Where Necessary: Use flexible metal conduit (FMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70.
- B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
- C. Provide conduit, fittings, supports, and accessories required for complete raceway system.
- D. Provide products listed, classified, and labeled as suitable for purpose intended.
- E. Minimum Conduit Size, Unless Otherwise Indicated:
 1. Branch Circuits: 3/4 inch (21 mm) trade size.
 2. Branch Circuit Homeruns: 3/4-inch trade size.
 3. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
 4. Underground, Interior: 3/4-inch trade size.
 5. Underground, Exterior: 3/4 inch (21 mm) trade size.
- F. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.3 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Manufacturers:
 1. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.com/#sle.
 2. Picoma: www.picoma.com.
 3. Wheatland Tube, a division of Zekelman Industries: www.wheatland.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.
- C. Fittings:
 1. Manufacturers:
 - a. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
 3. Material: Use steel.
 4. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.4 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.
- B. Fittings:
 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
 2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

CONDUIT FOR ELECTRICAL SYSTEMS

2.5 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
 - 2. Material: Use steel or malleable iron.
 - 3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.6 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

- A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.
- B. Fittings:
 - 1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.

2.7 PVC-COATED GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

- A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit with external polyvinyl chloride (PVC) coating complying with NEMA RN 1 and listed and labeled as complying with UL 6.
- B. Exterior Coating: Polyvinyl chloride (PVC), nominal thickness of 40 mil, 0.040 inch.
- C. PVC-Coated Boxes and Fittings:
 - 1. Manufacturer: Same as manufacturer of PVC-coated conduit to be installed.
 - 2. Nonhazardous Locations: Use boxes and fittings listed and labeled as complying with UL 514A, UL 514B, or UL 6.
 - 3. Material: Use steel or malleable iron.
 - 4. Exterior Coating: Polyvinyl chloride (PVC), minimum thickness of 40 mil, 0.040 inch.
- D. PVC-Coated Supports: Furnish with exterior coating of polyvinyl chloride (PVC), minimum thickness of 15 mil, 0.015 inch.

2.8 FLEXIBLE METAL CONDUIT (FMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
- B. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.
- C. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Material: Use steel or malleable iron.

2.9 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
 - 2. Electri-Flex Company: www.electriflex.com/#sle.
 - 3. International Metal Hose: www.metalhose.com/#sle.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

- B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use aluminum.

2.10 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
 - 1. Allied Tube & Conduit: www.alliedeg.com/#sle.
 - 2. Nucor Tubular Products: www.nucortubular/#sle.
 - 3. Wheatland Tube Company: www.wheatland.com/#sle.
- B. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.
- C. Fittings:
 - 1. Manufacturers:
 - a. Bridgeport Fittings, LLC: www.bptfittings.com/#sle.
 - b. Emerson Electric Co; O-Z/Gedney: www.emerson.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 3. Material: Use steel.
 - 4. Connectors and Couplings: Use set-screw type.
 - a. Do not use indenter type connectors and couplings.

2.11 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

- A. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.
- B. Fittings:
 - 1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
 - 2. Connectors and Couplings: Use compression/gland or set-screw type.

2.12 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:
 - 1. Cantex Inc: www.cantexinc.com/#sle.
 - 2. JM Eagle: www.jmeagle.com/#sle.
 - 3. Picoma: www.picoma.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 80 unless otherwise indicated; rated for use with conductors rated 90 degrees C, schedule 40 not permitted.
- C. Fittings:
 - 1. Manufacturer: Same as manufacturer of conduit to be connected.
 - 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.13 ACCESSORIES

- A. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
- B. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.
- C. Sealing Compound for Hazardous/Classified Location Sealing Fittings: Listed for use with particular fittings to be installed.
- D. Sealing Systems for Concrete Penetrations:
 - 1. Sleeves: Provide water stop ring or cement coating that bonds to concrete to prevent water infiltration.
 - 2. Rate for minimum of 40 psig; suitable for sealing around conduits to be installed.
- E. Bore Spacers: Nonmetallic; designed for maintaining conduit/duct spacing for installation within casing; furnished with roller wheels to facilitate installation, openings to facilitate grout flow, and holes for stabilization cable; suitable for casing and conduit/duct arrangement to be installed.
 - 1. Products:
 - a. Advance Products & Systems, LLC; Bore Spacers: www.apsonline.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Where conduit is installed on an existing wall, paint conduit to match the wall finish.
- C. Install conduit in accordance with NECA 1.
- D. Galvanized Steel Rigid Metal Conduit (RMC): Install in accordance with NECA 101.
- E. Intermediate Metal Conduit (IMC): Install in accordance with NECA 101.
- F. PVC-Coated Galvanized Steel Rigid Metal Conduit (RMC): Install using only tools approved by manufacturer.
- G. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.
- H. Conduit Routing:
 - 1. Unless dimensioned, conduit routing indicated is diagrammatic.
 - 2. When conduit destination is indicated without specific routing, determine exact routing required.
 - 3. Conceal conduits unless specifically indicated to be exposed.
 - 4. Conduits in the following areas may be exposed, unless otherwise indicated:
 - a. Electrical rooms.
 - b. Mechanical equipment rooms.
 - c. Within joists in areas with no ceiling.
 - 5. Conduits installed underground or embedded in concrete may be routed in shortest possible manner unless otherwise indicated. Route other conduits parallel or perpendicular to building structure and surfaces, following surface contours where practical.

6. Arrange conduit to maintain adequate headroom, clearances, and access.
 7. Arrange conduit to provide no more than the equivalent of three 90 degree bends between pull points.
 8. Route conduits above water and drain piping where possible.
 9. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
 10. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
 11. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
 - a. Heaters.
 - b. Hot water piping.
 - c. Flues.
 12. Group parallel conduits in same area on common rack.
- I. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 26 05 29.
 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
 3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
 4. Use conduit strap to support single surface-mounted conduit.
 - a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
 5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
 6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
 7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
 8. Use of spring steel conduit clips for support of conduits is not permitted.
 9. Use of wire for support of conduits is not permitted.
- J. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
 2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
 3. Use suitable adapters where required to transition from one type of conduit to another.
 4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
 5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
 6. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
 7. Secure joints and connections to provide mechanical strength and electrical continuity.
- K. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
 4. Conceal bends for conduit risers emerging above ground.
 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.

7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- L. Embedment Within Structural Concrete Slabs (only where approved by Structural Engineer):
 1. Secure conduits to prevent floating or movement during pouring of concrete.
- M. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide minimum concrete cover of 3 inches on all sides unless otherwise indicated; see Section 03 30 00.
- N. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 3. Where conduits are subject to earth movement by settlement or frost.
- O. Conduit Sealing:
 1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
 - a. Where conduits enter building from outside.
 - b. Where service conduits enter building from underground distribution system.
 - c. Where conduits enter building from underground.
 - d. Where conduits may transport moisture to contact live parts.
 2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
 - a. Where conduits pass from outdoors into conditioned interior spaces.
 - b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.
- P. Provide pull string in each empty conduit and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.
- Q. Provide grounding and bonding; see Section 26 05 26.
- R. Identify conduits; see Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- C. Where coating of PVC-coated galvanized steel rigid metal conduit (RMC) contains cuts or abrasions, repair in accordance with manufacturer's instructions.
- D. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

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

3.5 PROTECTION

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

END OF SECTION

CONDUIT FOR ELECTRICAL SYSTEMS

Section 26 05 33.13 Page 9

SECTION 26 05 33.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
- B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
- C. Boxes and enclosures for integrated power, data, and audio/video.
- D. Floor boxes.
- E. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- D. Section 26 05 33.13 - Conduit for Electrical Systems:
 - 1. Conduit bodies and other fittings.
 - 2. Additional requirements for locating boxes to limit conduit length and/or number of bends between pulling points.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 27 26 - Wiring Devices:
 - 1. Wall plates.
 - 2. Floor box service fittings.
 - 3. Additional requirements for locating boxes for wiring devices.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- C. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.
- E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

- I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.
- J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cabinets and enclosures, boxes for hazardous (classified) locations, floor boxes, and underground boxes/enclosures.
- C. Project Record Documents: Record actual locations for outlet and device boxes, pull boxes, cabinets and enclosures, floor boxes, and underground boxes/enclosures.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. Keys for Lockable Enclosures: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 BOXES

- A. General Requirements:
 - 1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.

2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
 3. Provide products listed, classified, and labeled as suitable for the purpose intended.
 4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
 5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
- B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
 2. Use cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
 3. Use cast aluminum boxes where exposed galvanized steel rigid metal conduit is used.
 4. Use suitable concrete type boxes where flush-mounted in concrete.
 5. Use suitable masonry type boxes where flush-mounted in masonry walls.
 6. Use raised covers suitable for the type of wall construction and device configuration where required.
 7. Use shallow boxes where required by the type of wall construction.
 8. Do not use "through-wall" boxes designed for access from both sides of wall.
 9. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
 10. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
 11. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
 12. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
 13. Wall Plates: Comply with Section 26 27 26.
 14. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hubbell Incorporated; Bell Products: www.hubbell-rtb.com/#sle.
 - c. Hubbell Incorporated; RACO Products: www.hubbell-rtb.com/#sle.
 - d. Thomas & Betts Corporation: www.tnb.com/#sle.
 - e. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
 2. NEMA EN 10250 Environment Type, Unless Otherwise Indicated:
 - a. Indoor Clean, Dry Locations: Type 1, painted steel.
 - b. Outdoor Locations: Type 4, painted steel.
 3. Junction and Pull Boxes Larger Than 100 cubic inches:
 - a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.
 - b. Boxes 6 square feet and Larger: Provide sectionalized screw-cover or hinged-cover enclosures.
 4. Finish for Painted Steel Enclosures: Manufacturer's standard grey unless otherwise indicated.
 5. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Hoffman, a brand of Pentair Technical Products: www.hoffmanonline.com/#sle.
 - c. Hubbell Incorporated; Wiegmann Products: www.hubbell-wiegmann.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Floor Boxes:
1. Description: Floor boxes compatible with floor box service fittings provided in accordance with Section 26 27 26; with partitions to separate multiple services; furnished with all components, adapters, and trims required for complete installation.
 2. Metallic Floor Boxes: Fully adjustable (with integral means for leveling adjustment prior to and after concrete pour).
 3. Manufacturer: Refer to floor box schedule on drawings for additional information.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide separate boxes for emergency power and normal power systems.
- E. Unless otherwise indicated, provide separate boxes for line voltage and low voltage systems.
- F. Flush-mount boxes in finished areas unless specifically indicated to be surface-mounted.
- G. Unless otherwise indicated, boxes may be surface-mounted where exposed conduits are indicated or permitted.
- H. Box Locations:
 - 1. Unless dimensioned, box locations indicated are approximate.
 - 2. Locate boxes as required for devices installed under other sections or by others.
 - a. Switches, Receptacles, and Other Wiring Devices: Comply with Section 26 27 26.
 - 3. Locate boxes so that wall plates do not span different building finishes.
 - 4. Locate boxes so that wall plates do not cross masonry joints.
 - 5. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
 - 6. Do not install flush-mounted boxes on opposite sides of walls back-to-back. Provide minimum 6 inches horizontal separation unless otherwise indicated.
 - 7. Acoustic-Rated Walls: Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches horizontal separation.
 - 8. Fire Resistance Rated Walls: Install flush-mounted boxes such that the required fire resistance will not be reduced.
 - a. Do not install flush-mounted boxes on opposite sides of walls back-to-back; provide minimum 24 inches separation where wall is constructed with individual noncommunicating stud cavities or protect both boxes with listed putty pads.
 - b. Do not install flush-mounted boxes with area larger than 16 square inches or such that the total aggregate area of openings exceeds 100 square inches for any 100 square feet of wall area.
 - 9. Locate junction and pull boxes as indicated, as required to facilitate installation of conductors, and to limit conduit length and/or number of bends between pulling points in accordance with Section 26 05 33.13.
 - 10. Locate junction and pull boxes in the following areas, unless otherwise indicated or approved by the Architect:
 - a. Concealed above accessible suspended ceilings.
 - b. Within joists in areas with no ceiling.
 - c. Electrical rooms.
 - d. Mechanical equipment rooms.
- I. Box Supports:

1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.
4. Use far-side support to secure flush-mounted boxes supported from single stud in hollow stud walls. Repair or replace supports for boxes that permit excessive movement.

J. Install boxes plumb and level.

K. Flush-Mounted Boxes:

1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.

L. Install boxes as required to preserve insulation integrity.

M. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

N. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

O. Close unused box openings.

P. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

Q. Provide grounding and bonding in accordance with Section 26 05 26.

R. Identify boxes in accordance with Section 26 05 53.

3.3 CLEANING

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

3.4 PROTECTION

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

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.
- B. Section 26 27 26 - Wiring Devices: Device and wallplate finishes; factory pre-marked wallplates.

1.3 REFERENCE STANDARDS

- A. ASTM D709 - Standard Specification for Laminated Thermosetting Materials; 2017.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. NFPA 70E - Standard for Electrical Safety in the Workplace; 2024.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
 - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
 - 2. Do not install identification products until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. 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.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

- B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.7 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 IDENTIFICATION APPLICATIONS

- A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.
- B. Identification for Equipment:
 - 1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
 - 2. In addition to identifying data specific to individual pieces of equipment listed, each equipment identification nameplate or label shall include a date of installation in a MM/YYYY format.
 - a. Switchgear:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - b. Switchboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Use identification nameplate to identify load(s) served for each branch device. Identify spares and spaces.
 - c. Panelboards:
 - 1) Identify ampere rating.
 - 2) Identify voltage and phase.
 - 3) Identify power source and circuit number. Include location.
 - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
 - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door. Identify spares and spaces.
 - 6) For power panelboards without a door, use identification nameplate to identify load(s) served for each branch device. Do not identify spares and spaces.
 - d. Transformers:
 - 1) Identify kVA rating.
 - 2) Identify voltage and phase for primary and secondary.
 - 3) Identify power source and circuit number. Include location.
 - 4) Identify load(s) served. Include location.
 - e. Enclosed switches, circuit breakers, and motor controllers:
 - 1) Identify voltage and phase.
 - 2) Identify power source and circuit number. Include location when not within sight of equipment.
 - 3) Identify load(s) served. Include location.
 - 3. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70 including but not limited to the following.
 - a. Service equipment.

4. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, meter socket enclosures, and motor control centers that are likely to require examination, adjustment, servicing, or maintenance while energized.
 - a. Minimum Size: 3.5 by 5 inches.
 - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required; Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.
 - c. Service Equipment: Include the following information in accordance with NFPA 70, 110.16.
 - 1) Nominal system voltage.
 - 2) Available fault current.
 - 3) Clearing time of service overcurrent protective device(s).
 - 4) Date label applied.
- C. Identification for Conductors and Cables:
 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
 2. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
 - a. At each source and load connection.
 - b. Within boxes when more than one circuit is present.
 - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
 - d. In cable tray, at maximum intervals of 20 feet.
 3. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
 4. Use underground warning tape to identify direct buried cables.
- D. Identification for Devices:
 1. Wiring Device and Wallplate Finishes: Comply with Section 26 27 26.
 2. Use identification label to identify fire alarm system devices.
 3. Use identification label to identify serving branch circuit for all receptacles.
- E. Identification for Luminaires:
 1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.

2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
 1. Manufacturers:
 - a. Brimar Industries, Inc: www.brimar.com/#sle.
 - b. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - c. Seton Identification Products: www.seton.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
 2. Materials: Conform to ASTM D709
 - a. Indoor Clean, Dry Locations: Use plastic nameplates.
 - b. Outdoor Locations: Use plastic nameplates suitable for exterior use.
 3. Plastic Nameplates: Three-layer laminated acrylic with beveled edges; minimum thickness of 1/8 inch; engraved text.
 - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
 - b. Color: Black letters on white background.
 4. Letter Size: Use 1/4 inch letters for identifying grouped equipment and loads.
 5. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
 1. Manufacturers:

- a. Brady Corporation: www.bradyid.com/#sle.
 - b. Brother International Corporation: www.brother-usa.com/#sle.
 - c. Panduit Corp: www.panduit.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
 - a. Use 3/16 inch black letters on clear background. Use only for identification of individual wall switches and receptacles, control device stations

2.3 WIRE AND CABLE MARKERS

- A. Manufacturers:
 1. Brady Corporation: www.bradyid.com/#sle.
 2. Seton Identification Products: www.seton.com.
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth type markers suitable for the conductor or cable to be identified.
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
- D. Legend: Power source and circuit number or other designation indicated.
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
- F. Minimum Text Height: 1/8 inch.
- G. Color: Black text on white background unless otherwise indicated.

2.4 VOLTAGE MARKERS

- A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- C. Minimum Size:
 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- D. Legend:
 1. Markers for System Identification:
 - a. Emergency Power System: Text "EMERGENCY".
 - b. Other Systems: Type of service.
- E. Color: Black text on orange background unless otherwise indicated.

2.5 UNDERGROUND WARNING TAPE

- A. Manufacturers:
 1. Brady Corporation: www.bradyid.com/#sle.
 2. Seton Identification Products: www.seton.com/#sle.
 3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Materials: Use foil-backed detectable type polyethylene tape suitable for direct burial, unless otherwise indicated.

- C. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil, unless otherwise required for proper detection.
- D. Legend: Type of service, continuously repeated over full length of tape.
- E. Color:
 - 1. Tape for Buried Power Lines: Black text on yellow background.
 - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
 - 1. Surface-Mounted Equipment: Enclosure front.
 - 2. Flush-Mounted Equipment: Inside of equipment door.
 - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
 - 4. Elevated Equipment: Legible from the floor or working platform.
 - 5. Branch Devices: Adjacent to device.
 - 6. Interior Components: Legible from the point of access.
 - 7. Conductors and Cables: Legible from the point of access.
 - 8. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
- D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
- E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
- F. Install underground warning tape above buried lines with one tape per trench at 6 inch(es) below finished grade.
 - 1. At paved areas, install 3 inches below pavement section.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION

SECTION 26 05 83
WIRING CONNECTIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical connections to equipment.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.
- C. Section 26 05 33.16 - Boxes for Electrical Systems.
- D. Section 26 27 26 - Wiring Devices.
- E. Section 26 28 16.16 - Enclosed Switches.

1.3 REFERENCE STANDARDS

- A. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).
- B. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
 - 2. Determine connection locations and requirements.
- B. Sequencing:
 - 1. Install rough-in of electrical connections before installation of equipment is required.
 - 2. Make electrical connections before required start-up of equipment.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide wiring device manufacturer's catalog information showing dimensions, configurations, and construction.
- C. 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.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Products: Listed, classified, and labeled as suitable for the purpose intended.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
 - 1. Colors: Comply with NEMA WD 1.
 - 2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
 - 3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
- B. Disconnect Switches: As specified in Section 26 28 16.16 and in individual equipment sections.
- C. Wiring Devices: As specified in Section 26 27 26.
- D. Flexible Conduit: As specified in Section 26 05 33.13.
- E. Wire and Cable: As specified in Section 26 05 19.
- F. Boxes: As specified in Section 26 05 33.16.

2.2 EQUIPMENT CONNECTIONS

- A. Refer to equipment Schedules on drawing for specific requirements for each piece of equipment.:
 - 1. Electrical Connection: Flexible conduit.
 - 2. Electrical Connection: Cord and plug (NEMA 6-20R).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.2 ELECTRICAL CONNECTIONS

- A. Make electrical connections in accordance with equipment manufacturer's instructions.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Provide receptacle outlet to accommodate connection with attachment plug.
- E. Provide cord and cap where field-supplied attachment plug is required.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
- H. Install terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.

END OF SECTION

SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Vacancy sensors.
- B. Outdoor photo controls.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems
- D. Section 26 05 33.16 - Boxes for Electrical Systems.
- E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- F. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches and wall dimmers.
 - 1. Includes finish requirements for wall controls specified in this section.
 - 2. Includes accessory receptacles, switches, dimmers and wall plates, to match lighting controls specified in this section.
- G. Section 26 51 00 - Interior Lighting.

1.3 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. ANSI C136.24 - American National Standard for Roadway and Area Lighting Equipment - Nonlocking (Button) Type Photocontrols; 2020.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.
- E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of lighting control devices with millwork, furniture, equipment and other potential conflicts.
 - 2. Coordinate the placement of vacancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.

3. Coordinate placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement.
4. Coordinate lighting control device product selections with luminaire characteristics; see Section 26 51 00 and lighting fixture schedule.

B. Sequencing:

1. Do not install lighting control devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include ratings, operating modes or sequence of functions, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
 1. Vacancy Sensors: Include detailed motion detection coverage range diagrams.
- C. Operation and Maintenance Data: Include detailed information on device programming and setup.
- D. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

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

PART 2 PRODUCTS

2.1 LIGHTING CONTROL DEVICES - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for purpose intended.
- B. Unless specifically indicated as excluded, provide components necessary for complete operating system including, but not limited to, conduit, wiring, connectors, hardware, and accessories.

2.2 VACANCY SENSORS

- A. Manufacturers:
 1. Hubbell Incorporated: www.hubbell.com/#sle.
 2. Legrand North America, Inc: www.legrand.us/#sle.
 3. Lutron Electronics Company, Inc: www.lutron.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
 5. Source Limitations: Furnish products produced by single manufacturer and obtained from single supplier.

- B. All Vacancy Sensors:
 - 1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
 - 2. Sensor Technology:
 - a. Passive Infrared/Ultrasonic Dual Technology Vacancy Sensors: Designed to detect vacancy using a combination of both passive infrared and ultrasonic technologies.
 - 3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
 - 4. Operation: Unless otherwise indicated, load to be manual on and automatic off when no occupant presence is detected during an adjustable turn-off delay time interval.
 - 5. Dual Technology Vacancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
 - 6. Passive Infrared Lens Field of View: Field customizable by addition of factory masking material, adjustment of integral blinders, or similar means to block motion detection in selected areas.
 - 7. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
 - 8. Sensitivity: Field adjustable.
 - 9. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
 - 10. Load Rating for Line Voltage Vacancy Sensors: As required to control the load indicated on drawings.
 - 11. Provide with auxiliary relay: SPDT dry contacts.
- C. Ceiling Mounted Vacancy Sensors:
 - 1. All Ceiling Mounted Vacancy Sensors:
 - a. Unless otherwise indicated or required to control load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
 - b. Finish: White unless otherwise indicated.
 - c. Provide with auxiliary relay: SPDT dry contact
 - 2. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Vacancy Sensors:
 - a. Standard Range Sensors: Capable of detecting motion within area of 450 square feet at mounting height of 9 feet, with field of view of 360 degrees.
 - 1) Products:
 - (a) Hubbell NXOS series.
 - (b) Substitutions: See Section 01 60 00 - Product Requirements.
- D. Power Packs for Low Voltage Vacancy Sensors:
 - 1. Load Rating: As required to control load indicated on drawings.

2.3 OUTDOOR PHOTO CONTROLS

- A. Manufacturers:
 - 1. Tork, a division of NSI Industries LLC: www.tork.com/#sle.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Stem-Mounted Outdoor Photo Controls:
 - 1. Description: Direct-wired photo control unit with threaded conduit mounting stem and field-adjustable swivel base, listed and labeled as complying with UL 773A.
 - 2. Housing: Weatherproof, impact resistant polycarbonate.
 - 3. Photo Sensor: Cadmium sulfide.
 - 4. Provide external sliding shield for field adjustment of light level activation.
 - 5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
 - 6. Voltage: As required to control load indicated on drawings.
 - 7. Failure Mode: Fails to the on position.
 - 8. Load Rating: As required to control load indicated on drawings.
- C. Button Type Outdoor Photo Controls

1. Description: Direct-wired photo control unit complying with ANSI C136.24 with weatherproof gasketed wall plate where required or indicated, listed and labeled as complying with UL 773A.
2. Housing: Weather resistant polycarbonate.
3. Photo Sensor: Cadmium sulfide.
4. Light Level Activation: 1 to 3 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with delayed turn-off.
5. Voltage: As required to control load indicated on drawings.
6. Failure Mode: Fails to the on position.
7. Load Rating: As required to control load indicated on drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
- F. Verify that service voltage and ratings of lighting control devices are appropriate for service voltage and load requirements at location to be installed.
- G. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes as required for installation of lighting control devices; see Section 26 05 33.16.
 1. Mounting Heights: Unless otherwise indicated, as follows:
 - a. Wall Switch Vacancy Sensors: 48 inches above finished floor.
 2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
 3. Locate wall switch vacancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
- C. Maintain separation of remote-control, signaling, and power-limited circuits.
 1. See manufacturer instructions and Section 26 05 19 for control wiring conductors, wiring methods, and identification requirements.
- D. Install lighting control devices in accordance with manufacturer's instructions.

- E. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
- F. Install lighting control devices plumb and level, and held securely in place.
- G. Provide required supports; see Section 26 05 29.
- H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
- I. Identify lighting control devices; see Section 26 05 53.
- J. Vacancy Sensor Locations:
 - 1. Location Adjustments: Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
- K. Outdoor Photo Control Locations:
 - 1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
 - 2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by photo control itself.
- L. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into photo control.
- M. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near sensor location.
- N. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.
- O. Unless otherwise indicated, install switches on load side of power packs so that switch does not turn off power pack.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Test vacancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area.
- D. Test outdoor photo controls to verify proper operation, including time delays where applicable.
- E. Correct wiring deficiencies and replace damaged or defective conductors, cables, and lighting control devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust vacancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
- C. Adjust position of directional vacancy sensors and outdoor motion sensors to achieve optimal coverage as required.

- D. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology vacancy sensor lenses to block undesired motion detection.
- E. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.
- C. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Qualified contractor familiar with the project and with sufficient knowledge of installed lighting control devices.
 - 4. Location: At project site.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Low-voltage (600 V and less) switchboards and associated accessories for service and distribution applications.
- B. Overcurrent protective devices for switchboards.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- C. Section 26 05 29 - Hangers and Supports for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
- B. IEEE C57.13 - IEEE Standard Requirements for Instrument Transformers; 2016.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- D. NECA 400 - Standard for Installing and Maintaining Switchboards; 2007.
- E. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- F. NEMA PB 2 - Deadfront Distribution Switchboards; 2011.
- G. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 1000 Volts or Less; 2023.
- H. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- I. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- J. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- K. UL 891 - Switchboards; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.

3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
4. Coordinate with manufacturer to provide shipping splits suitable for the dimensional constraints of the installation.
5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Service Entrance Switchboards:

1. Coordinate with Utility Company to provide switchboards with suitable provisions for electrical service and utility metering, where applicable.
2. Coordinate with Owner to arrange for Utility Company required access to equipment for installation and maintenance.
3. Obtain Utility Company approval of switchboard prior to fabrication.
4. Arrange for inspections necessary to obtain Utility Company approval of installation.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store switchboards in accordance with manufacturer's instructions, NECA 400, and NEMA PB 2.1.
- B. Store in a clean, dry space having a uniform temperature to prevent condensation (including outdoor switchboards, which are not weatherproof until completely and properly installed). Where necessary, provide temporary enclosure space heaters or temporary power for permanent factory-installed space heaters.
- C. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Switchboards:
1. Schneider Electric: www.se.com/#sle.
 2. Siemens Industry, Inc: www.new.siemens.com/#sle.
 3. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 SWITCHBOARDS

- A. Provide switchboards consisting of all required components, control power transformers, instrumentation and control wiring, accessories, etc. as necessary for a complete operating system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.

- C. Description: Dead-front switchboard assemblies complying with NEMA PB 2, and listed and labeled as complying with UL 891; ratings, configurations and features as indicated on the drawings.
- D. Service Conditions:
 - 1. Provide switchboards and associated components suitable for operation under the following service conditions without derating:
 - a. Altitude: Less than 6,600 feet.
 - b. Ambient Temperature:
 - 1) Switchboards Containing Molded Case or Insulated Case Circuit Breakers: Between 23 degrees F and 104 degrees F.
 - 2. Provide switchboards and associated components suitable for operation at indicated ratings under the service conditions at the installed location.
- E. Short Circuit Current Rating:
 - 1. Minimum Rating: 65,000 rms symmetrical amperes.
- F. Main Devices: Configure for top or bottom incoming feed as indicated or as required for the installation. Provide separate pull section and/or top-mounted pullbox as indicated or as required to facilitate installation of incoming feed.
- G. Bussing: Sized in accordance with UL 891 temperature rise requirements.
 - 1. Through bus (horizontal cross bus) to be fully rated through full length of switchboard (non-tapered). Tapered bus is not permitted.
 - 2. Provide solidly bonded equipment ground bus through full length of switchboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
 - 3. Phase and Neutral Bus Material: Aluminum.
 - 4. Ground Bus Material: Aluminum.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
 - 1. Line Conductor Terminations:
 - a. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - b. Main and Neutral Lug Type: Mechanical.
 - 2. Load Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - b. Lug Type:
 - 1) Provide mechanical lugs unless otherwise indicated.
- I. Enclosures:
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - 2. Finish: Manufacturer's standard unless otherwise indicated.
- J. Future Provisions:
 - 1. Prepare designated spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.
- K. Instrument Transformers:
 - 1. Comply with IEEE C57.13.
 - 2. Select suitable ratio, burden, and accuracy as required for connected devices.
 - 3. Current Transformers: Connect secondaries to shorting terminal blocks.
 - 4. Potential Transformers: Include primary and secondary fuses with disconnecting means.

2.3 OVERCURRENT PROTECTIVE DEVICES

- A. Circuit Breakers:
 - 1. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than specified minimum requirements.

- b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
- 2. Molded Case Circuit Breakers:
 - a. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers; listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - b. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - 1) Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
 - 2) Provide interchangeable trip units where indicated.
 - c. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.

2.4 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test switchboards according to NEMA PB 2, including the following production (routine) tests on each switchboard assembly or component:
 - 1. Dielectric tests.
 - 2. Mechanical operation tests.
 - 3. Grounding of instrument transformer cases test.
 - 4. Electrical operation and control wiring tests, including polarity and sequence tests.
 - 5. Ground-fault sensing equipment test.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the switchboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive switchboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install switchboards in accordance with NECA 1 (general workmanship), NECA 400, and NEMA PB 2.1.
- C. Arrange equipment to provide required clearances and maintenance access, including accommodations for any drawout devices.
- D. Where switchboard is indicated to be mounted with inaccessible side against wall, provide minimum clearance of 1/2 inch between switchboard and wall.
- E. Provide required support and attachment in accordance with Section 26 05 29.
- F. Install switchboards plumb and level.
- G. Unless otherwise indicated, mount switchboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

- H. Provide grounding and bonding in accordance with Section 26 05 26.
- I. Install all field-installed devices, components, and accessories.
- J. Where accessories are not self-powered, provide control power source as indicated or as required to complete installation.
- K. Provide filler plates to cover unused spaces in switchboards.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Before energizing switchboard, perform insulation resistance testing in accordance with NECA 400 and NEMA PB 2.1.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Perform inspections and tests listed in NETA ATS, Section 7.1.
- E. Molded Case and Insulated Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers and circuit breakers larger than 200 amperes. Tests listed as optional are not required.
- F. Instrument Transformers: Perform inspections and tests listed in NETA ATS, Section 7.10. The dielectric withstand tests on primary windings with secondary windings connected to ground listed as optional are not required.
- G. Correct deficiencies and replace damaged or defective switchboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of switchboard covers and doors.

3.5 CLEANING

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

3.6 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Training: Train Owner's personnel on operation, adjustment, and maintenance of switchboard 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.

3.7 PROTECTION

- A. Protect installed switchboards from subsequent construction operations.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Power distribution panelboards.
- B. Lighting and appliance panelboards.
- C. Overcurrent protective devices for panelboards.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service; 2013e, with Amendments (2022).
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA 407 - Standard for Installing and Maintaining Panelboards; 2015.
- D. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- E. NEMA PB 1 - Panelboards; 2011.
- F. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 1000V or Less; 2023.
- G. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- J. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- K. UL 67 - Panelboards; Current Edition, Including All Revisions.
- L. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures; Current Edition, Including All Revisions.
- M. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.
- N. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- O. UL 1699 - Arc-Fault Circuit-Interrupters; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
 - 2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
 - 4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
- C. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
- D. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Panelboard Keys: Two of each different key.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature within the following limits during and after installation of panelboards:
 - 1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- B. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- C. Source Limitations: Provide panelboards and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from a single supplier.

2.2 PANELBOARDS - GENERAL REQUIREMENTS

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature:
 - a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
- C. Short Circuit Current Rating:
 - 1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
- D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.
- F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.
- G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
 - 1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
 - 2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
- H. Conductor Terminations: Suitable for use with the conductors to be installed.
- I. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Boxes: Galvanized steel unless otherwise indicated.
 - a. Provide wiring gutters sized to accommodate the conductors to be installed.
 - 3. Fronts:
 - a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
 - b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
 - c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
 - 4. Lockable Doors: All locks keyed alike unless otherwise indicated.
- J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

2.3 POWER DISTRIBUTION PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase and Neutral Bus Material: Copper.
 - 2. Ground Bus Material: Copper.
- D. Circuit Breakers:
 - 1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
 - 2. Provide thermal magnetic circuit breakers unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted enclosures unless otherwise indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
 - 3. Provide metal circuit directory holder mounted on inside of door.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

- A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.
- B. Conductor Terminations:
 - 1. Main and Neutral Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 2. Main and Neutral Lug Type: Mechanical.
- C. Bussing:
 - 1. Phase Bus Connections: Arranged for sequential phasing of overcurrent protective devices.
 - 2. Phase and Neutral Bus Material: Copper.
 - 3. Ground Bus Material: Copper.
 - a. Provide insulated ground bus where indicated.
- D. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.
- E. Enclosures:
 - 1. Provide surface-mounted or flush-mounted enclosures as indicated.
 - 2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded Case Circuit Breakers:
 - 1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
 - 2. Interrupting Capacity:
 - a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
 - 1) 10,000 rms symmetrical amperes at 240 VAC or 208 VAC.
 - 2) 14,000 rms symmetrical amperes at 480 VAC.
 - b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.

PANELBOARDS

3. Conductor Terminations:
 - a. Provide mechanical lugs unless otherwise indicated.
 - b. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
 - a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
 - a. Provide the following field-adjustable trip response settings:
 - 1) Long time pickup, adjustable by setting dial.
 - 2) Long time delay.
 - 3) Short time pickup and delay.
 - 4) Ground fault pickup and delay where ground fault protection is indicated.
6. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.
7. Provide the following circuit breaker types where indicated:
 - a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.
 - b. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Combination type listed as complying with UL 1699.
8. Provide type HACR for air conditioning equipment circuits.
9. Do not use tandem circuit breakers.
10. Provide the following features and accessories where indicated or where required to complete installation:
 - a. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.
 - b. Handle Pad-Lock Provision: For locking circuit breaker handle in OFF position.

2.6 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive panelboards.
- D. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Install panelboards in accordance with NECA 407 and NEMA PB 1.1.
- 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 26 05 29.

- F. Install panelboards plumb.
- G. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.
- H. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.
- I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling.
- J. Provide grounding and bonding in accordance with Section 26 05 26.
- K. Install all field-installed branch devices, components, and accessories.
- L. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- M. Provide filler plates to cover unused spaces in panelboards.
- N. Identify panelboards in accordance with Section 26 05 53.
- O. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Inspect and test in accordance with NETA ATS, except Section 4.
- D. Fusible Switches: Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- E. Molded Case Circuit Breakers: Perform inspections and tests listed in NETA ATS, Section 7.6.1.1 for all main circuit breakers. Tests listed as optional are not required.
- F. Test GFCI circuit breakers to verify proper operation.
- G. Test AFCI circuit breakers to verify proper operation.
- H. Test shunt trips to verify proper operation.
- I. Correct deficiencies and replace damaged or defective panelboards or associated components.

3.4 ADJUSTING

- A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
- B. Adjust alignment of panelboard fronts.
- C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.5 CLEANING

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

END OF SECTION

SECTION 26 27 26
WIRING DEVICES - HUBBELL EDGECONNECT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wiring devices with screwless termination system:
 - 1. Switches.
 - 2. Straight blade receptacles.
 - 3. Plugs and connectors.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; 2014h (Validated 2022).
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification); 2017g (Validated 2023).
- C. NEMA WD 6 - Wiring Devices - Dimensional Specifications; 2021.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- F. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of outlet boxes for wiring devices; see Section 26 05 33.16.
 - 2. Coordinate wiring device ratings and configurations with equipment electrical requirements.
- B. Sequencing:
 - 1. Do not install wiring devices until final surface finishes and painting are complete.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets, including termination method and available ratings, configurations, and colors.

1.6 QUALITY ASSURANCE

- A. Comply with NFPA 70.

- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum 3 years of experience.
- C. Product Evaluation and Listing Organization Qualifications: Organization engaged in evaluation of products and services, including those recognized by OSHA as National Recognized Testing Laboratories (NRTL), and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in clean, dry space in original manufacturer's packaging until ready for installation.

PART 2 PRODUCTS

2.1 WIRING DEVICES - GENERAL REQUIREMENTS

- A. Screwless Termination System:
 - 1. Utilize screwless spring termination to eliminate strand relaxation for improved wire retention and vibration performance.
 - 2. No tools (e.g., screwdriver, torque wrench) required for termination of conductors.
 - 3. Termination Color Code:
 - a. Phase Conductors: Black or Red.
 - b. Neutral Conductors: White.
 - c. Grounding Conductors: Green.

2.2 SWITCHES

- A. Listed as complying with UL 20.
- B. Comply with FS W-S-896 where applicable.
- C. Provide integral conductor strip gauge.
- D. Contacts: Silver alloy.
- E. Automatic self-grounding.

2.3 PLUGS AND CONNECTORS

- A. Listed as complying with UL 498.
- B. Provide compatible weatherproof boots for devices as indicated or as required.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify field measurements.
- B. Verify location and mounting height of outlet boxes.
- C. Verify that outlet boxes are sized to accommodate devices and conductors in accordance with NFPA 70.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Install wiring devices in accordance with manufacturer's instructions.
- B. Provide grounding and bonding; see Section 26 05 26.
- C. Adjust wiring devices and associated wall plates to be flush and level.
- D. Identify wiring devices; see Section 26 05 53.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect wiring device for damage and defects.
- C. Operate switches with circuit energized to verify operation.
- D. Test receptacles to verify operation and polarity.
- E. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material.

END OF SECTION

SECTION 26 28 13
FUSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.

1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.1 APPLICATIONS

- A. Service Entrance:
 - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
- B. Feeders:

1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.

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

2.2 FUSES

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

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

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

D. Comply with UL 248-1.

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

F. Voltage Rating: Suitable for circuit voltage.

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

H. Class L Fuses: Comply with UL 248-10.

2.3 SPARE FUSE CABINET

A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.

PART 3 EXECUTION

3.1 EXAMINATION

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

B. Verify that mounting surfaces are ready to receive spare fuse cabinet.

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

3.2 INSTALLATION

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

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

C. Install spare fuse cabinet where indicated.

D. Identify spare fuse cabinet in accordance with Section 26 05 53.

END OF SECTION

SECTION 26 28 16.16
ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Enclosed safety switches.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 28 13 - Fuses.

1.3 REFERENCE STANDARDS

- A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- B. NEMA EN 10250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2024.
- C. NEMA BS 31047 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum); 2013 (Reaffirmed 2023).
- D. NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment And Systems; 2025.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.
- G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.
- H. UL 98 - Enclosed and Dead-Front Switches; Current Edition, Including All Revisions.
- I. UL 869A - Reference Standard for Service Equipment; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for enclosed switches and other installed components and accessories.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 FIELD CONDITIONS

- A. Maintain ambient temperature between -22 degrees F and 104 degrees F during and after installation of enclosed switches.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Eaton Corporation; Cutler Hammer: www.eaton.com/#sle.
- B. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
- C. Siemens Industry, Inc: www.usa.siemens.com/#sle.
- D. Substitutions: See Section 01 60 00 - Product Requirements.
- E. Source Limitations: Provide enclosed switches and associated components produced by same manufacturer as other electrical distribution equipment used for project and obtained from single supplier.

2.2 ENCLOSED SAFETY SWITCHES

- A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
 - 1. Altitude: Less than 6,600 feet.
 - 2. Ambient Temperature: Between -22 degrees F and 104 degrees F.
- D. Horsepower Rating: Suitable for connected load.

- E. Voltage Rating: Suitable for circuit voltage.
- F. Enclosed Safety Switches Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
- G. Provide with switch blade contact position that is visible when the cover is open.
- H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.
- I. Conductor Terminations: Suitable for use with the conductors to be installed.
- J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.
- K. Enclosures: Comply with NEMA EN 10250, and list and label as complying with UL 50 and UL 50E.
 - 1. Environment Type per NEMA EN 10250: Unless otherwise indicated, as specified for the following installation locations:
 - a. Indoor Clean, Dry Locations: Type 1.
 - b. Outdoor Locations: Type 3R.
 - 2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
- L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.
- M. Heavy Duty Switches:
 - 1. Comply with NEMA BS 31047.
 - 2. Conductor Terminations:
 - a. Lug Material: Aluminum, suitable for terminating aluminum or copper conductors.
 - 3. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install enclosed switches plumb.
- F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

- G. Provide grounding and bonding in accordance with Section 26 05 26.
- H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
- I. Identify enclosed switches in accordance with Section 26 05 53.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.1.1.
- D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.

3.4 ADJUSTING

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

3.5 CLEANING

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

END OF SECTION

SECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior luminaires.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.

1.3 REFERENCE STANDARDS

- A. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems; 2006.
- B. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- C. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2023.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
 - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 3. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
- C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
- E. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide 5-year pro-rata warranty for batteries for emergency lighting units.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
- G. Recessed Luminaires:

1. Ceiling Compatibility: Comply with NEMA LE 4.
2. Luminaires Recessed in Sloped Ceilings: Provide suitable sloped ceiling adapters.

2.3 ACCESSORIES

- A. Chain hang pendant luminaires in utilitarian spaces.
- B. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.
- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Suspended Ceiling Mounted Luminaires:
 1. Do not use ceiling tiles to bear weight of luminaires.
 2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
 3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
 4. Secure pendant-mounted luminaires to building structure.
 5. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
 6. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gauge, connected from opposing corners of each recessed luminaire to building structure.
 7. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
- G. Recessed Luminaires:

1. Install trims tight to mounting surface with no visible light leakage.
2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.

H. Suspended Luminaires:

1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet between supports.
4. Install canopies tight to mounting surface.

I. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.

J. Install accessories furnished with each luminaire.

K. Bond products and metal accessories to branch circuit equipment grounding conductor.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
- B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.

3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

3.9 ATTACHMENTS

- A. Luminaire schedule located on contract drawings.

END OF SECTION

SECTION 26 56 00
EXTERIOR LIGHTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Exterior luminaires.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 26 09 23 - Lighting Control Devices.
- D. Section 31 23 23 - Fill: Backfilling of Light Pole Bases.

1.3 REFERENCE STANDARDS

- A. IEEE C2 - National Electrical Safety Code(R) (NESC(R)); 2023.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2000 (Reaffirmed 2006).
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
 - 2. Notify Architect of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.6 QUALITY ASSURANCE

- A. Comply with requirements of NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.8 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide 5-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in luminaire schedule included on the drawings.

2.2 LUMINAIRES

- A. Provide products that comply with requirements of NFPA 70.
- B. Provide products that are listed and labeled as complying with UL 1598, where applicable.
- C. Provide products listed, classified, and labeled as suitable for the purpose intended.
- D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
- E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
- F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of luminaires provided under this section.

- B. Install products in accordance with manufacturer's instructions.
- C. Install luminaires in accordance with NECA/IESNA 501.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
- F. Pole-Mounted Luminaires:
 - 1. Maintain the following minimum clearances:
 - a. Comply with IEEE C2.
 - b. Comply with utility company requirements.
 - 2. Foundation-Mounted Poles:
 - a. Provide Precast Concrete Pole Bases as specified.
 - b. Coordinate installation of bases with all other affected trades.
 - c. Excavation for Pole Bases shall be either open cut or auger drilling, and create a minimum of six inch annular space around the perimeter of the base..
 - d. Compact base of excavation prior to adding manufacturer's recommended stone setting base.
 - e. Install foundations plumb, and support during backfilling to maintain plumb.
 - f. Backfill according to manufacturer's recommendations and in accordance with Section 31 23 23.
 - g. Repair any exposed surfaces damaged by installation to match color and texture of surrounding surfaces.
 - h. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
 - i. Tighten anchor bolt nuts to manufacturer's recommended torque.
 - 3. Grounding:
 - a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.
 - 4. Install separate service conductors, 12 AWG copper, from each luminaire down to handhole for connection to branch circuit conductors.
- G. Install accessories furnished with each luminaire.
- H. Bond products and metal accessories to branch circuit equipment grounding conductor.
- I. Install lamps in each luminaire.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.5 ADJUSTING

- A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.6 CLEANING

- A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrostatic Discharge (ESD) Hardware.
- B. Grounding Busbars.
- C. Telecommunications Equipment Bonding Conductors.
- D. Beam Grounding Clamps.
- E. Bonding Hardware.
- F. Wire.
- G. Mechanical connectors.

1.2 RELATED REQUIREMENTS

- A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Section 27 05 53 - Identification For Communications Systems.

1.3 REFERENCE STANDARDS

- A. BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition; 2020.
- B. NECA/BICSI 607 - Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings; 2011.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2021).
- E. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords; Current Edition, Including All Revisions.
- F. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, For submittal procedures.
- B. Product Data: Submit product data on grounding and bonding equipment and connections.
- C. Test Reports: Indicate overall resistance to earth ground.
- D. Manufacturer's Installation Instructions: Submit for active electrodes.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Manufacturer's Qualification Statement.
- G. Installer's Qualification Statement.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

1.6 QUALITY ASSURANCE

- A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDMM Manual, TIA-607, and NFPA 70.
 - 1. Maintain one copy of each document on site.
- B. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system.
- C. Cables and cable assemblies shall be VW-1 flame rated and comply with UL 1581 and CSA Certified.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction, such as UL.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements, for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN MANUFACTURER

- A. Panduit: www.panduit.com.
- B. Or Approved Equal.

- C. Substitutions: See Section 01 60 00 - Product Requirements, for substitution procedures.

2.2 SYSTEM DESCRIPTION

- A. The purpose of this grounding system is to create a low impedance path to earth ground for electrical surges and transient voltages. Lightning, fault currents, circuit switching (motors turning on and off), and electrostatic discharge (ESD) are common causes of these surges and transient voltages. An effective grounding system minimizes the detrimental effects of these electrical surges, which include degraded network performance and reliability and increased safety risks.
- B. The grounding system must be intentional, visually verifiable, adequately sized to handle expected currents safely, and directs these potentially damaging currents away from sensitive network equipment. As such, grounding must be purposeful in its design and installation. The following four issues require special consideration:
1. Although AC powered equipment typically has a power cord that contains a ground wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding above and beyond that which is specified by local electrical codes, such as the National Electrical Code. Always follow the grounding recommendations of the manufacturer when installing equipment.
 2. While the building steel and metallic water piping must be bonded to the grounding system for safety reasons, neither may be substituted for the telecommunications bonding backbone (TBB).
 3. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. Hardware typically supplied with bolt-together racks is not designed for grounding purposes. Additionally, most racks are painted and paint is an insulator. Unless rack members are deliberately bonded, continuity between members is incidental, and in many cases, unlikely.
 4. Any metallic component that is part of the data center, including equipment, racks, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding system.
- C. The communications grounding systems shall use the Building Grounding Electrode as the grounding element.
1. The following elements shall not be acceptable as grounding electrodes:
 - a. Building Plumbing System.
 - b. Gas Piping System.
 - c. Fire Sprinkler System.

2.3 GENERAL

- A. Two-hole lugs shall be used wherever possible to resist loosening when twisted (bumped) or exposed to vibration. All lugs shall be irreversible compression and meet NEBS Level 3 as tested by Telcordia. Lugs with inspection windows shall be used in all non-corrosive environments so that connections may be inspected for full conductor insertion.
- B. Die index numbers shall be embossed on all compression connections to allow crimp inspection.
- C. Lugs, HTAPs, grounding strips, and busbars shall be UL Listed and made of premium quality tin-plated electrolytic copper that provides low electrical resistance while inhibiting corrosion.
- D. Antioxidant shall be used when making bonding connections in the field.

2.4 GROUNDING BUSBARS

- A. General:
1. Meeting NECA/BICSI 607 and TIA-607 requirements for network systems bonding applications.
 2. Rectangular copper bar, tin-plated to inhibit corrosion.
 3. Pre-assembled mounting bracket, fully insulated from busbar.
 4. Pre-drilled paired holes to accommodate two hole lugs, quantity as determined by size of busbar required:
 - a. 1/4 inch stud holes, 5/8 inch on center.
 - b. 3/8 inch stud holes, 1 inch on center.

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

2.5 GROUNDING AND BONDING WIRE

- A. All grounding and bonding conductors shall be insulated stranded copper wire.
 - 1. Jackets shall be VW-1 Flame Rated in accordance with UL 1581.
 - a. Color: Distinctive green or green/yellow.
- B. The Telecommunications Grounding Busbar (TGB) in each telecommunications space shall be grounded / earthed to the Telecommunications Main Grounding Busbar (TMGB) located at the service entrance. The gauge of the connecting copper ground / earth cable, known as the Telecommunications Bonding Backbone (TBB) shall follow BICSI TDMM Manual and TIA-607 guidelines, as is shown in the table below.

TBB Length in Linear feet	TBB Size (AWG)
Less than 13	6
14 - 20	4
21 - 26	3
27 - 33	2
34 - 41	1
42 - 52	1/0
53 - 66	2/0
Greater than 66	3/0

- C. The TMGB will be bonded to building steel and grounded to the electrical service ground according to BICSI TDMM Manual and TIA-607 guidelines. In telecommunications spaces with only one rack, the rack jumper cable shall be connected directly to the TGB. The gauge of connecting copper ground cables shall be sized as shown in the table below.

Equipment / Purpose	Copper Cable Size (AWG)
Bonding conductor to each PDU or panel board serving the room	Size per NEC 250.122 and manufacturer requirements
Conduits, water pipes, and ducts	6
Bonding conductor to HVAC equipment	6
Cable trays / ladder racks	6
Building columns	4
Aisle grounds (over head or under floor) of the common bonding network	1/0

2.6 COMPRESSION LUGS

- A. Lugs shall meet NEBS Level 3 requirements as tested by Telcordia.
- B. Two hole lugs for connection of grounding wire to busbars, racks, cabinets, all data equipment, cable runway, building steel, etc.
 - 1. Combination hole and slot may be used for greater flexibility in connectivity.
 - a. Field modification of mounting holes shall not be accepted.
- C. Long barrel to maximize number of crimps and reduce pullout of copper conductors.
 - 1. Barrel shall have inspection window to ensure full conductor insertion.
 - 2. Ground conductor shall be fully crimped by compatible power crimper and dies.
 - a. Hand crimping of lugs shall not be accepted.
- D. Tin plated copper to inhibit corrosion.
- E. Product:
 - 1. Code Conductor

Model: LCC-W Series

2.7 RACK / CABINET EQUIPMENT GROUNDING JUMPER CABLES GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

- A. Bolt-on bonding jumper that connects rack to the vertical rack grounding bar.
 - 1. Conductor: #6 AWG insulated stranded copper.
 - 2. Factory terminated with one straight slotted lug, and one 90 degree bent slotted lug.
 - 3. Length: 60 inches, minimum.
- B. Product:
 - 1. Equipment Jumper Kit Model RGEJ660U

2.8 VERTICAL RACK GROUND BAR KIT

- A. Tin plated copper conductor that attaches vertically to the rack equipment mounting rails to provide connection of rack mounted equipment with jumper to the telecommunications grounding busbar.
 - 1. 78.65 inch long, 0.67 inch wide, 0.05 inch thick, nominal.
- B. Product:
 - 1. Ground Bar Kit- Threaded Rail Model RGS134-1Y
 - 2. Ground Bar Kit- Cage Nut Rail Model RGS134B-1

2.9 ELECTROSTATIC DISCHARGE (ESD) PORT KIT AND WRIST STRAP

- A. Two hole ESD port with 5/8 inch hole spacing.
 - 1. Bent at 45 degree angle to hold wrist strap.
 - 2. Permanently marked with protective earth (ground) symbol.
- B. Wrist strap: Adjustable fabric to provide rapid and continuous drain of electrostatic charge between a person and the surface that the wrist strap is bonded to.
 - 1. Connection: Six foot coiled cord with 1 megohm resistor and banana plug for insertion into ESD port.
- C. Provide one wrist strap and ESD port at each rack or cabinet to prevent damaging static discharge into equipment.
- D. Product:
 - 1. ESD Wrist Strap Model RGEDWS
 - 2. ESD Port Kit for Threaded Rails Model RGED2-1
 - 3. ESD Port Kit for Cage Nut Rails Model RGED2B-1

2.10 CABLE TRAY / LADDER RUNWAY GROUNDING BRACKETS

- A. Grounding brackets for cable trays and ladder runway within telecommunications spaces.
 - 1. Serves as routing and support for overhead grounding conductors along cable trays and ladder runways.
 - 2. Provides bonding between cable trays or ladder runways when used with ladder runway bonding jumper kit.
- B. Product:
 - 1. Auxiliary Cable Brackets Model GACB-2

2.11 LADDER RUNWAY BONDING JUMPER KIT

- A. Bolt-on bonding jumper that connects cable tray and ladder runway brackets.
 - 1. Conductor: #6 AWG insulated stranded copper.
 - 2. Factory terminated with two straight long barrel two hole lugs.
- B. Provides grounding pathway between ladder runway or cable tray splices when used with auxiliary cable brackets.
- C. Product:
 - 1. Auxiliary Cable Bracket Jumper Kit
 - a. Length: 8" Model GACBJ68U

- b. Length: 12" Model GACBJ612U
c. Length: 18" Model GACBJ618U

2.12 GROUNDING CLAMP FOR CONDUITS

- A. Dual rated for copper conductors to copper pipe, galvanized pipe or steel conduit.
- B. High strength aluminum alloy.
 - 1. Tin plated for corrosion and oxidation resistance.
- C. Product:
 - 1. Pipe Grounding Clamp (0.5"- 1" Pipe) Model GC-15A-Q
 - 2. Pipe Grounding Clamp (1.25" - 2" Pipe) Model GC-18A-X
 - 3. Pipe Grounding Clamp (2.5"- 4" Pipe) Model GC-22A-4

2.13 UNIVERSAL BEAM GROUNDING CLAMP

- A. Copper grounding clamp in conformance with UL 467.
 - 1. Provides mounting pad suitable for a two-hole compression lug.
 - 2. Suitable on steel flanges from 1/4 inch through 5/8 inch.
- B. Provide for any grounding connections made to beams.
- C. Product:
 - 1. Universal Beam Grounding Clamp Model GUBC500-6

2.14 SPLIT BOLT COPPER GROUNDING CLAMP

- A. High strength copper alloy.
 - 1. Pressure bar with hex nut tightening.
- B. Grounding connection for wire tray / baskets.
- C. Product:
 - 1. Split Bolt - Copper Model SBC3-C
 - 2. Split Bolt - Copper: Tin-Plated for galvanized Model SBCT3-C

2.15 BONDING HARDWARE KITS

- A. Bonding studs and nuts: Steel.
1. Paint piercing serrations to create bonding point between the rack or cabinet and painted patch panels, mounted equipment, servers, busbars, and jumpers.
 2. Color: Green, to indicate bonding application.
- B. Product:
1. Bonding Stud Kit:
 - a. For threaded #12-24 rail fasteners Model TRBSK
 - b. For threaded M6 rail fasteners Model TRBSM6K
 - c. For cage nut rail fasteners Model CGNBSK
 2. Bonding Nuts:
 - a. For threaded #12-24 rail fasteners Model BGN-C
 - b. For cage nut rail fasteners Model BGN-C
 - c. For 1/4" thru-hole rail fasteners Model BGN-C
 - d. For threaded M6 rail fasteners Model BGNM6-C

2.16 PAINT PIERCING GROUNDING WASHER KIT

- A. Bonds frame members on bolt-together racks.
- B. Product:

1. Paint Piercing Grounding Washer Kit Model RGW-100-1Y

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points using an abrasive pad and provide antioxidant compound.
- B. Antioxidant shall be used when making all bonding connections in the field.

3.2 INSTALLATION

- A. Install in accordance with BICSI TDMM Manual, TIA-607, and NFPA 70.
- B. Install all components in accordance with manufacturer's installation instructions.
- C. Install all components of the grounding system in a manner so that they are intentional, visually verifiable, adequately sized to handle expected currents safely, and to direct potentially damaging currents away from sensitive network equipment.
- D. Install grounding for each rack / cabinet using 6 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor to copper communication grounding bus bar located in main telecommunications entrance facility.
- E. No "daisy chaining" of racks / cabinets, each rack / cabinet shall have it's own independent connection to the telecommunications grounding bar within the data room either through a main common bonding network or homerun.
- F. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with 3/0 AWG copper stranded conductor.
- G. Install routing for grounding conductor as short and direct as practical.
- H. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.
- I. Position grounding busbars near associated equipment and insulate from supports.
- J. Ground data cabinets, racks, cable trays, air conditioning unit, building structure, metal piping and metal conduit located in all data rooms to the Telecommunications Grounding Busbar (TGB).
- K. Install ground from each piece of equipment to MDF Room and IDF Room to grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Power crimp proper grounding lug on cable where connecting to grounding bar.
- L. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines and Section 27 05 53 - Identification For Communications Systems.
- M. Permanently attach equipment and grounding conductors prior to energizing equipment.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. See Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- C. Visually inspect from each bus bar to main grounding electrode service location.

- D. Test in accordance with BICSI TDMM Manual, TIA-607 and NFPA 70.
- E. When improper grounding is found during testing, check entire project, perform corrections, and perform retesting.
- F. Installations not conforming to BICSI TDMM Manual, TIA-607 and NFPA 70 shall be subject to manufacturer grounding audit to identify correction requirements. Grounding audit and corrections required shall be at the expense of the contractor performing the improper installation.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. J-Hooks
- B. Cable Ties
- C. Conduit Sleeves
- D. Bushings

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 27 05 26 - Grounding and Bonding For Communications Systems.

1.3 REFERENCE STANDARDS

- A. NEMA BI 50015 - Metal Cable Tray Systems; 2024.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.
- D. NEMA VE 2 - Metal Cable Tray Installation Guidelines.
- E. ANSI/UL 5 - Surface Metal Raceways and Fittings.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. See Section 01 30 00 - Administrative Requirements for Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.5 SCOPE

- A. The Interior Communications Pathways will provide a distribution system for all system cabling that will be served by the systems shown on contract drawings. The pathways for a building may include all or some of the following, cable tray, continuous conduit systems, conduit stubs, sleeves, fire rated pathways, cable hangers, surface raceways. Interior pathway design shall follow all BICSI TDMM design recommendations and TIA568-B and TIA569-A standards.
 - 1. Cabling pathways will be concealed wherever possible.
 - 2. Corridors/Rooms/Spaces with inaccessible ceiling spaces (spline type ceilings, Hard ceilings) will require surface raceway on walls or ceilings.
 - 3. Exposed conduit and Raceway shall be run parallel and at right angles to building lines, and be painted to match existing surfaces.

1.6 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for all products specified in this Section.
- C. Shop Drawings: Include plan views indicating locations and routing.
 - 1. Indicate proposed arrangement for Conduit pathway runs, Conduit Sleeve penetrations, and Conduits to be installed within structural concrete slabs (where permitted).
 - 2. Indicate proposed arrangement for J Hook pathways.
- D. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- E. Project Record Documents: Record actual routing of Major Pathways and locations of supports for cable tray.

1.7 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.1 CABLE TRAY SYSTEM - GENERAL REQUIREMENTS

- A. Provide new cable tray system consisting of all required components, fittings, supports, accessories, etc. as necessary for a complete system.
- B. Provide products listed, classified, and labeled as suitable for the purpose intended.
- C. Do not use cable tray for applications other than as permitted by NFPA 70 and product listing/classification.
- D. Provide cable tray system and associated components suitable for use at indicated span/load ratings under the service conditions at the installed location.
- E. Unless otherwise indicated, specified span/load ratings are based on safety factor of 1.5 and working load only (no additional concentrated static load), with ratings for metal cable tray systems in accordance with NEMA BI 50015.
- F. Unless otherwise indicated, specified load/fill depths and inside widths are nominal values, with values for metal cable tray systems in accordance with NEMA BI 50015 including applicable allowable tolerances.

2.2 FIRE RATED CONDUIT PENETRATIONS

- A. Description: The firestop assembly for use in through-penetration firestop systems. The assembly shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete and block walls and shall match the fire rating of the wall/floor that is being penetrated. The assembly shall be classified for use in one-, two-, and three-hour rated concrete floors. Firestop between wall opening and around outside of conduit sleeves with Firestop material per Section 07 84 00.
- B. Firestop Assembly(s) shall be in accordance with All applicable codes and Standards. Provide intumescent removable firestop forming material and putty around cables within conduit sleeves, or Fire Rated Conduit Sleeve Fittings for conduits 2" Dia. and above.
- C. All conduit sleeves to have bushings or fittings for cable protection.
- D. Provide acceptable grounding connection on conduit sleeves/bushings/fittings to allow for connection of ground wire per Sections 26 05 26, 27 05 26.

2.3 SURFACE RACEWAYS

- A. Where required in inaccessible locations, including but not limited to above splined or hard ceilings, provide surface raceways.

2.4 J-HOOKS

- A. Saddle style cable supports / hangers.
 - 1. Non-metallic cable support hook to prevent metal to cable contact, with integral cable retaining means.
 - 2. Appropriate metallic hanging means for attachment to walls, ceilings, threaded rods, beams or purlins.
 - 3. Tested and Listed in accordance with UL 2043 as suitable for use in air handling spaces.
 - 4. Bundle capacity: Two inches, minimum.
- B. Product:
 - 1. Panduit; J Pro Cable Support: www.panduit.com.
 - 2. Or Approved Equal
 - 3. Substitutions: Section 01 60 00 - Product Requirements.

2.5 CABLE TIES

- A. Reusable and releasable hook-and-loop style ties.
 - 1. Width: 0.75 inch, minimum.
 - 2. Operating range: -22 degrees F to 194 degrees F.
 - 3. Color: Black.
- B. Zip Ties shall not be permitted.

2.6 CONDUIT BUSHINGS

- A. Steel Conduit: Rigid Intermediate Grade, insulated, with screws or clips for ground wire connection
- B. PVC Conduit: non-steel, insulated

PART 3 EXECUTION

3.1 EXISTING CONDITIONS WORK

- A. Maintain access to existing cable tray and other pathway installations remaining active and requiring access. Modify installation or provide access panel to otherwise inaccessible spaces.
- B. All pathways shall be evaluated prior to adding any cabling within.
- C. Existing conduit sleeve pathways that are re-used shall not be filled beyond 40% fill factor and shall be firestopped. See Section 07 84 00 - Firestopping.
- D. Existing cable tray pathways that are re-used shall not be filled beyond 40% fill factor and where applicable at wall penetrations, shall be firestopped per applicable ratings and codes.
- E. Existing Conduit Sleeve penetrations that are abandoned shall be Firestopped/infilled per applicable ratings and codes.

3.2 INSTALLATION

- A. Support all pathways and fasten to structure with hardware specifically designed to support the total weight of the pathway and all included cables. Install supports at each connection point, at end of each run, and at other points to maintain the weight limit and to withstand cable pulling.

- B. Firestop Assembly(s) shall be labeled in accordance with UL F ratings and T ratings at both sides of penetration. Provide label on wall below / near the firestop assembly in a location that is easily seen.
- C. J Hooks: Install cable types in separate open cable hanger segment. Do not mix coaxial, optical fiber cable or any other cable type in the same support. If cables have more than 12 inches of sag, install additional J-Hooks. Cables to maintain minimum 4 inches above ceiling grid. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- D. If a conduit run requires:
 - 1. More than two 90 degree bends, provide a pull point or pull box between sections with two bend or fewer.
 - 2. A reverse bend (between 100 degrees and 180 degrees) insert a pull point or pullbox at each bend having an angle from 100 degrees and 180 degrees.
 - 3. A third 90 degree bend (between pull points or pull boxes) Derate conduit capacity of the run that has the third bend by 15% except when:
 - a. the total run is not longer than 33 feet.
 - b. the conduit size is increased.
 - c. One of the bends is located within 12 inches of the cable end feed.
- E. Maintain Conduit Bend Radius:
 - 1. 4-pair balanced twisted pair (CAT 6) - 4 times the outside diameter (at rest or during pull).
 - 2. Multipair balanced twisted pair cable - 10 times the outside diameter.
 - 3. Telecommunications bonding backbone- 3 times the outside diameter.
- F. Where raceways or cable trays penetrate fire-rated walls, floors or roofs, sleeve and seal opening around raceways and cable trays with UL listed firestop assemblies equal to fire rating of walls, floors or roofs. Seal penetrations through all floors or roofs to provide and maintain a watertight installation. Conduit sleeves, where required, shall be sized for proper sealing and extend Min. 2 inches above the surface. The installation shall be in compliance with UL listed firestopping assembly.
- G. Conduits shall be:
 - 1. Clean dry and unobstructed
 - 2. Reamed and fitted with bushings. Metal conduits to have ground clip / ground wire connectors
 - 3. Labeled for identification
 - 4. Equipped with a pull cord that has a min. test rating of 90kg (200lb.)
- H. A pull cord that has a min. test rating of 90kg (200lb. shall be co-installed with all cable installed in any pathway.
- I. Cable pathways shall not be filled greater than the TIA/EIA-569-A maximum fill for the particular type.
- J. Pathways deemed overfilled upon installation will not be accepted and shall be remedied at Contractor expense.
- K. Install expansion connectors where recommended by manufacturer as indicated on Drawings.
- L. Install firestopping in accordance with Section 07 84 00 to sustain ratings when passing cable pathway through fire-rated elements.

3.3 CLOSEOUT ACTIVITIES

- A. See Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual routing of Major Pathways and locations of supports for cable tray.

END OF SECTION

SECTION 27 05 29
HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

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

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 27 05 33.13 - Conduit for Communications Systems: Additional support and attachment requirements for conduits.
- C. Section 27 10 05 - Communications Copper Cabling.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition; 2022.
- E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- F. MFMA-4 - Metal Framing Standards Publication; 2004.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- I. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).

1.4 ADMINISTRATIVE REQUIREMENTS

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

1. Do not install products on or provide attachment to concrete surfaces until concrete has cured; see Section 03 30 00.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for cable supports, channel/strut framing systems, and post-installed concrete/masonry anchors.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
- D. Installer's qualification statement.
- 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.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.
- B. Product Listing Organization Qualifications: Organization recognized by OSHA as Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 1. Comply with the following. Where requirements differ, comply with most stringent.
 - a. TIA-569.
 - b. NFPA 70.
 - c. Requirements of authorities having jurisdiction.
 2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of communications work.
 3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
 4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
 5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
 6. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 7. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
 - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

- d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Conduit Supports: Straps and clamps suitable for conduit to be supported.
 - 1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
 - 2. Conduit Clamps: Bolted type unless otherwise indicated.
- C. Noncontinuous Cable Supports: Suitable for cables to be supported, including but not limited to J-hooks, bridle rings, drive rings, and flexible harnesses/slings.
 - 1. Manufacturers:
 - a. Panduit; J Pro Cable Support: www.panduit.com/#sle.
 - b. Or Approved Equal.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
 - 2. Applications:
 - a. Do not exceed 5 feet between cable supports.
 - b. Maximum Number of Cables per Cable Support:
 - c. Allowable Cable Types:
 - 1) J-Hooks: Category 5e, Category 6, and Category 6A.
 - 3. J-Hooks: Noncontinuous cabling support with removable top retainer.
 - a. Material: Use galvanized steel, stainless steel, or nylon.
 - b. Provide non-metallic support surfaces with smooth, beveled edges and radius not less than minimum allowable bend radius of cables supported.
 - c. Bundle Capacity: Two inches, minimum.
 - d. Provide multitiered J-hooks where required to support multiple cabling systems.
- D. Cable Ties
 - 1. Reusable and releasable hook-and-loop style ties.
 - a. Width: 0.75 inch, minimum.
 - b. Operating range: -22 to 194 degrees F.
 - c. Color: Black.
 - 2. Zip Ties shall not be permitted.
- E. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.
- F. Metal Channel/Strut Framing Systems:
 - 1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
 - 2. Comply with MFMA-4.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use zinc-plated 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 wide by 13/16 inch high.
- G. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2-inch diameter.
 - b. Single Conduit up to 1-inch (27 mm) Trade Size: 1/4-inch diameter.
 - c. Single Conduit Larger than 1-inch (27 mm) Trade Size: 3/8-inch diameter.
 - d. Trapeze Support for Multiple Conduits: 3/8-inch diameter.
 - e. Outlet Boxes: 1/4-inch diameter.
- H. Anchors and Fasteners:
 - 1. Manufacturers - Mechanical Anchors:
 - a. Dewalt: anchors.dewalt.com/#sle.
 - b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Red Head, a division of Illinois Tool Works, Inc: www.itwredhead.com/#sle.
 - 2. Manufacturers - Powder-Actuated Fastening Systems:
 - a. Dewalt: anchors.dewalt.com/#sle.

- b. Hilti, Inc: www.hilti.com/#sle.
 - c. ITW Ramset, a division of Illinois Tool Works, Inc: www.ramset.com/#sle.
- 3. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.
- 4. Concrete: Use expansion anchors or screw anchors.
- 5. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
- 6. Hollow Masonry: Use toggle bolts.
- 7. Hollow Stud Walls: Use toggle bolts.
- 8. Steel: Use beam clamps or machine bolts.
- 9. Sheet Metal: Use sheet metal screws.
- 10. Wood: Use wood screws.
- 11. Powder-actuated fasteners are permitted only as follows:
 - a. Use only threaded studs; do not use pins.
- 12. Hammer-driven anchors and fasteners are not permitted.
- 13. Preset Concrete Inserts: Continuous metal channel/strut and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Manufacturer: Same as manufacturer of metal channel/strut framing system.
 - b. Comply with MFMA-4.
 - c. Channel Material: Use galvanized steel.
 - d. Minimum Channel Thickness: Steel sheet, 12 gauge, 0.1046 inch minimum base metal thickness.
- 14. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install hangers and supports in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- D. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- H. Equipment Support and Attachment:
 - 1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
 - 2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide 1 inch minimum 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.
 5. Rigidly weld support members or use hexagon-head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.
 6. Install surface-mounted cabinets and panelboards with minimum of four anchors.
 7. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.
- I. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- J. Secure fasteners in accordance with manufacturer's recommended torque settings.
- K. Remove temporary supports.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect support and attachment components for damage and defects.
- C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
- D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 27 05 33.13
CONDUIT FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Rigid polyvinyl chloride (PVC) conduit.
- B. High-density polyethylene (HDPE) conduit.
- C. Polyvinyl chloride (PVC) plastic utilities duct.
- D. Inside-plant flexible nonmetallic communications raceway/innerduct.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 33.13 - Conduit for Electrical Systems.

1.3 REFERENCE STANDARDS

- A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.
- B. ASTM F2160 - Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD); 2016.
- C. ASTM F2176 - Standard Specification for Mechanical Couplings Used on Polyethylene Conduit, Duct and Innerduct; 2017.
- D. BICSI ITSIMM - Information Technology Systems Installation Methods Manual (ITSIMM), 8th Edition; 2022.
- E. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- F. BICSI TDMM - Telecommunications Distribution Methods Manual, 14th Edition; 2020.
- G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- H. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC); 2017.
- I. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit; 2020.
- J. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing; 2021.
- K. NEMA TC 7 - Solid-Wall Coilable and Straight Electrical Polyethylene Conduit; 2021.
- L. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- M. TIA-568.0 - Generic Telecommunications Cabling for Customer Premises; 2020e.
- N. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).
- O. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings; Current Edition, Including All Revisions.

- P. UL 651A - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conduits and fittings.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 CONDUIT APPLICATIONS

- A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, TIA-569, BICSI ITSIMM, BICSI TDMM, manufacturers' instructions, and product listing.
- B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

2.2 CONDUIT - GENERAL REQUIREMENTS

- A. Comply with NFPA 70 and TIA-569.
- B. Provide conduit, fittings, supports, and accessories required for complete communications pathway.
- C. Provide products listed, classified, and labeled as suitable for purpose intended.
- D. Where conduit size is not indicated, size to comply with NFPA 70, TIA-569, and BICSI TDMM, but not less than applicable minimum size requirements specified. Where specified standards differ, comply with most stringent.

2.3 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

- A. Manufacturers:

1. ABB; Carlon: www.electrification.us.abb.com/#sle.
 2. Allied Tube & Conduit, a division of Atkore International: www.alliedeg.us/#sle.
 3. Cantex Inc: www.cantexinc.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage.
- C. Fittings:
1. Manufacturer: Same as manufacturer of conduit to be connected.
 2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.
 3. Conduit Bodies: Use only conduit bodies specifically designed for communications cabling. Standard conduit bodies designed for electrical raceways are not permitted.
 - a. Comply with TIA-568.0 minimum bend radius requirements for fiber optic cables.

2.4 HIGH-DENSITY POLYETHYLENE (HDPE) CONDUIT

- A. Manufacturers:
1. ABB; Carlon: www.electrification.us.abb.com/#sle.
 2. Blue Diamond Industries, LLC: www.bdiky.com/#sle.
 3. Eastern Wire + Conduit, a division of Atkore International: www.easternwire.com/#sle.
 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Description: NFPA 70, Type HDPE high-density polyethylene solid-wall conduit complying with ASTM F2160 and NEMA TC 7; list and label as complying with UL 651A; Schedule 40 unless otherwise indicated.
- C. Joining Methods: Approved by HDPE conduit manufacturer.
- D. Mechanical Fittings: Comply with ASTM F2176; list and label as complying with UL 651A.

2.5 UNDERGROUND MARKING

- A. Underground markings shall comply with AWWA Uniform Color Code.
- B. Tracer Wire: Continuous 12 AWG, Solid, Copper clad high strength steel, with minimum 30 mil HDPE insulation, orange in color, suitable for direct burial.
- C. Warning Tape:
1. Detectable Warning Tape: Magnetic detectable warning tape, 6 inches wide, 5 mil thick tape with aluminum backing, clear plastic covering, imprinted with "Buried Communications Line" in large black letters on orange background.

2.6 ACCESSORIES

- A. Outside-Plant Fabric Innerduct:
1. Designed for installation in underground raceways.
 2. Detectable Innerduct:
 - a. Includes integral, magnetic detectable tracer wire, minimum 18 AWG copper.
 - b. Provide NFPA 70 required bonding of metal components in accordance with manufacturer written instructions.
 3. Products:
 - a. Maxcell Innerduct: www.maxcell.us/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.

- C. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf.

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install conduit in accordance with NECA 1, BICSI ITSIMM, and BICSI N1.
- C. Rigid Polyvinyl Chloride (PVC) Conduit: Install in accordance with NECA 111.
- D. Conduit Support:
 - 1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction.
 - 2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- E. Connections and Terminations:
 - 1. Use suitable adapters where required to transition from one type of conduit to another.
 - 2. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect cables.
 - 3. Secure joints and connections to provide mechanical strength and electrical continuity.
- F. Penetrations:
 - 1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
 - 2. Make penetrations perpendicular to surfaces unless otherwise indicated.
 - 3. Provide sleeves and/or slots for penetrations as indicated or as required to facilitate installation.
 - 4. Conceal bends for conduit risers emerging above ground.
 - 5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
 - 6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
 - 7. Install firestopping to preserve fire resistance rating of partitions and other elements; see Section 07 84 00.
- G. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed cables or connected equipment. This includes, but is not limited to:
 - 1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
 - 2. Where calculated in accordance with NFPA 70 for rigid polyvinyl chloride (PVC) conduit installed above ground to compensate for thermal expansion and contraction.
 - 3. Where conduits are subject to earth movement by settlement or frost.
- H. Provide grounding and bonding.

3.3 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Correct deficiencies and replace damaged or defective conduits.

3.4 CLEANING

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

3.5 PROTECTION

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

END OF SECTION

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Labels
- B. Wire markers
- C. Conduit markers

1.2 RELATED REQUIREMENTS

- A. Section 27 05 26 - Grounding and Bonding For Communications Systems.
- B. Section 27 10 05 - Communications Copper Cabling.
- C. Section 27 11 16 - Communications Cabinets, Racks, Enclosures, & Accessories.
- D. Section 27 15 23 - Communications Optical Fiber Cabling.

1.3 REFERENCE STANDARDS

- A. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.
- B. TIA-606-B - Administration Standard for Telecommunications Infrastructure; Rev B, 2012 (with Addenda; 2015).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard product data sheet, including part number and description for each product
- C. Shop Drawings: Submit labeling plan for review and approval prior to commencing labeling.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN MANUFACTURER

- A. Panduit: www.panduit.com.
- B. Or approved equal.
- C. Substitutions: See Section 01 60 00 - Product Requirements, for substitution procedures.

2.2 LABELS AND WIRE MARKERS

- A. Comply with the requirements of TIA-606 and TIA-606-B standards.
- B. Thermal transfer, laser, or inkjet type.
- C. Lettering: Black on white background.

1. Sized according to label; not less than 1/8 inch.

D. Application:

1. Cat6 Cables	Self Laminating	Model	S050X150YAJ
2. Fiber Cables	Sleeve	Model	NWSLC-2Y
a.	Label	Model	S100X150YAJ
3. Faceplates	Non-Adhesive	Model	UJLS8BW
4. Patch Panels	Non-Adhesive	Model	UJLS8BW
5. Ground Busbars	Super-tack	Model	C200X100YPT
6. Grounding/ Bonding Conductors	Tag	Model	LTYK
7. Data Outlets	Non-Adhesive	Model	C195X040Y1J

2.3 CONDUIT AND RACEWAY MARKERS

A. Vinyl snap-on, non-adhesive:

1. Fiber Conduit and Innerduct Label Model PCV-FORY

PART 3 EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Follow manufacturer's requirements for preparation.
- C. Install identifying devices after completion of any painting.

3.2 INSTALLATION

- A. Follow manufacturer's requirements for installation.
- B. Mark data cabling within 2 inches from each end. Install additional marking at accessible locations along the cable run.
- C. All labels shall be installed such that they will be visible following installation.
 1. Install parallel to cables or equipment lines.
- D. Contractor shall install identification on all of the following:
 1. Copper Horizontal Cabling at each end.
 2. Data Outlets and connectors at each end.
 3. Copper Patch Panels.
 4. Fiber Cabling at each end.
 5. Fiber connectors at each end.
 6. Fiber Patch Panels.
 7. Communications Grounding Busbars.
 8. Communications Grounding and Bonding Conductors.
 9. Security Cameras.
 10. Wireless Access Points.
 11. Speaker Cabling.
- E. All labeling nomenclature shall comply with TIA-606-B cable labeling standards and as further outlined below:
 1. Data Outlets (any faceplate or surface mount box containing cat-6 data jacks)
 - a. Data outlet labels to indicate TR-RK-PP-PRT where:
 - 1) TR = 2-digit number of Telecommunications Room
 - 2) RK = 2-digit number of Rack
 - 3) PP = 2-digit number of Patch-Panel
 - 4) PRT = 2-digit number port designation of patch-panel

IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

- b. Data Outlets serving security cameras and wireless access points shall follow the same protocol outlined above.

END OF SECTION

SECTION 27 10 05
COMMUNICATIONS COPPER CABLING

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 33.16 - Boxes for Electrical Systems.
- C. Section 27 05 26 - Grounding and Bonding For Communications Systems.
- D. Section 27 05 28 - Pathways For Communications Systems.
- E. Section 27 05 53 - Identification For Communications Systems.
- F. Section 27 15 55 - Communications Cable Testing.

1.2 REFERENCE STANDARDS

- A. BICSI N1 - Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure, 1st Edition; 2019.
- B. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.
- C. FM (AG) - FM Approval Guide; Current Edition.
- D. ICEA S-90-661 - Category 3 and 5E Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communication Wiring Systems; 2021.
- E. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air Handling Spaces.
- G. TIA-568 (SET) - Commercial Building Telecommunications Cabling Standard Set; 2024.
- H. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).
- I. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.
- J. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2021).
- K. UL (DIR) - Online Certifications Directory; Current Edition.
- L. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- M. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.

2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages, specifications and data sheets for each product incorporated into the Work.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- D. Evidence of qualifications for installer.
- E. Installer certification from the cable manufacturer MUST be submitted as part of the bid de-scoping process. The Certified Installer certificate cannot be site specific to this project and must be pre-existing for 12 months prior to the bid due date.
- 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, installation, and operation of product.
- G. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- H. Field Test Reports.
- I. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 1. Record actual locations of outlet boxes and distribution frames.
 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 3. Identify distribution frames and equipment rooms by room number on drawings.
- J. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a one year period after Date of Substantial Completion.
- C. Manufacturer shall provide a complete Cable Products Static, Dynamic, and Applications Warranty for a period of 20 years for high performance cabling systems that meet application requirements. The warranty shall include all cable installed in the structured cabling system.
- D. Warranty shall be written in the name of the Owner, and include the following:
 1. Identification of the Manufacturer's Certified Installer.

2. That the Installer has completed the Manufacturer's Certification Program.
3. That the Installer has fulfilled all the requirements of the Manufacturer's Certified Program.

PART 2 PRODUCTS

2.1 CATEGORY 6 UNSHIELDED HORIZONTAL CABLE (PLENUM RATED)

- A. Product Description: Enhanced Category 6 TIA/EIA 568-B.2-1, 100-ohm, unshielded twisted pair plenum rated cable with 4 pairs, 23 AWG solid bare annealed copper conductors, 100% FEP Insulation. Cable shall be manufactured in the United States of America. Cable shall be UL LISTED. Cable shall be third party verified to meet ANSI/TIA/EIA 568-B.2-1, Category 6 requirements.
- B. Manufacturers:
- | | |
|--------------------------------------|-----------------------|
| 1. Panduit CAT-6 Cable | Model - PUP6004BU-UY |
| 2. Belden CAT-6 Cable | Model - 3613 D15U1000 |
| 3. Berk-Tek CAT-6 Cable Lanmark-1000 | Model - 10032094 |
| 4. Superior Essex CAT-6 Cable | Model - 66-246-2P |
| 5. General Cable CAT-6 Cable | Model - 7131900 |
- C. Color:
- | | |
|---------------------------|--------|
| 1. General Use Data | Blue |
| 2. Wireless Access Points | Blue |
| 3. Security Cameras | Orange |

2.2 CATEGORY 6A HORIZONTAL CABLE (PLENUM RATED)

- A. Product Description: Category 6A, 100-ohm, plenum rated cable, 23 AWG copper conductors twisted in 4 pairs and separated by a cross-divider. The cable shall be compliant with IEEE 802.3af and IEEE 802.3at POE applications. The cable shall be capable of 10GBase-T Ethernet.
- B. Manufacturers:
- | | |
|--------------------------------|-------------------------|
| 1. Panduit CAT-6A Cable | Model - PUP6AV04BU-G |
| 2. Belden CAT-6A Cable | Model - 10GXS13D15A1000 |
| 3. Berk-Tek CAT-6A Cable | Model - 11082057 |
| 4. Superior Essex CAT-6A Cable | Model - 6S-220-2P |
| 5. General Cable CAT-6A Cable | Model - 7151839 |
- C. Color:
- | | |
|---------------------------|--------|
| 1. General Use Data | Blue |
| 2. Wireless Access Points | Blue |
| 3. Security Cameras | Orange |

2.3 CATEGORY 6 DATA JACKS

- A. Product Description: RJ45, 8-position, 8-wire universal module. Contacts plated with 50 micro inches of gold. Compatible with Mini-Com Modular Patch Panels, Faceplates, and Surface Mount Boxes. Termination shall be accomplished by use of a forward motion termination cap and shall not require the use of a punch down tool. The modules shall be able to be re-terminated a minimum of 10 times. Do not untwist cable pairs more than 0.125 in. (3.18mm) when terminating. Wiring Scheme: T568B
1. Shuttered CAT6 Jacks to be used for all above ceiling applications unless otherwise noted.
 2. Corrosive Resistant Jacks to be used in harsh/humid environments.
- B. Manufacturers:
- | | |
|---|----------------|
| 1. CAT6 - Panduit Mini-Com TX6 PLUS Jack | Model CJ688TG |
| 2. CAT6 - Panduit Mini-Com TX6 PLUS Shuttered Jack | Model CJH688TG |
| 3. CAT6 - Panduit Mini-Com TX6 PLUS Corrosive Resist Jack | Model CJE688TG |
| 4. CAT 6 - Belden REVConnect CAT6+ Jack Bulk | Model RV6MJKU |

5. CAT 6 - Ortronics Clarity HDJ6 Jack Model PR-HDJ6

- C. Color:
1. General Use Data Blue
 2. Wireless Access Points Blue
 3. Security Cameras Orange

2.4 CATEGORY 6A DATA JACKS

- A. Product Description: Augmented Category 6, 8-position, 8-wire universal module. Contacts plated with 50 micro inches of gold. Compatible with Mini-Com Modular Patch Panels, Faceplates, and Surface Mount Boxes. Terminates 4 pair 22-26 AWG, 100 ohm cable and shall not require the use of a punch down tool. Wiring Scheme: T568B
1. Shuttered CAT6A Jacks to be used for all above ceiling applications unless otherwise noted.
 2. Corrosive Resistant Jacks to be used in harsh/humid environments.
- B. Manufacturers:
1. CAT6A - Panduit Mini-Com TX6 10Gig Jack Model CJ6X88TG
 2. CAT6A - Panduit Mini-Com TX6 10Gig Shuttered Jack Model CJH6X88TG
 3. CAT6A - Belden CAT 6A REVConnect CAT6A Jack Bulk Model RVAMJKU
 4. CAT6A - Ortronics Clarity HDJ6A Jack Model OR-HDJ6A
- C. Color:
1. General Use Data Blue
 2. Wireless Access Points Blue
 3. Security Cameras Orange

2.5 MANUFACTURERS' JACK COLOR CHART

COLOR	PANDUIT	BELDEN	ORTRONICS
BLUE	BU	BL	-36
ORANGE	OR	OR	-43
GREEN	GR	GN	-45
SLATE	IG	GY	-78
WHITE	WH	EW	-88
RED	RD	RD	-42
BLACK	BL	BK	0
YELLOW	YL	YL	-44
VIOLET	VL	PR	-27
IVORY	IW	IV	-13
ALMOND	EI	AL	

2.6 CATEGORY 6 PATCH CABLES

- A. Product Description: Category 6, 28 AWG UTP patch cords with TX6 PLUS Modular Plugs on each end. Exceed ANSI/TIA-568-C.2 Category 6 and ISO 11801 Class E Standards.
- B. Manufacturers:
1. Panduit Patch Cables (for Data Room End - 1 Per Data drop) Model UTP28SP[x]**
 2. Panduit Patch Cables (for Device End - 1 Per Data drop) Model UTP28SP[x]**
 3. Panduit 36" Patch Cables (for Surge Protection Device - 1 Per Data drop requiring surge protection) Model UTPSP30RY
 4. Belden Category 6 Small Diameter Patch Cables (where xxx equals footage length) Model C6D11006xxx
 5. Ortronics Patch Cables (for Data Room End - 1 Per Data drop) Model OR-MC6[xx]-06
 6. Ortronics Patch Cables (for Device End - 1 Per Data drop) Model OR-MC6[xx]-06

7. Ortronics 36" Patch Cables (for Surge Protection Device - 1 Per Data drop requiring surge protection) Model MC603-03

C. Lengths:

1. Data room end Locations with Data Cabinets 3 foot ([x] = 3)
2. Data room end Locations with Data Racks 6 foot ([x] = 6)
3. Wireless access point device location 6 foot ([x] = 6)
4. Security Camera device location 6 foot ([x] = 6)
5. General Data outlet location 10 foot ([x] = 10)

D. Color:

1. General Use Data Blue
2. Wireless Access Points Blue
3. Security Cameras Orange

E. Additional Installation notes:

1. Contractor to establish proper wire management for patch cables from patch panels to switches. "Spider Webbing" with patch cables will not be accepted.

2.7 CATEGORY 6A PATCH CABLES

- A. Product Description: Category 6A, 28 AWG, 10 Gb/s UTP patch cord with TX6A 10Gig Modular Plugs on each end.

B. Manufacturers:

1. Panduit Patch Cables (for Data Room End - 1 Per Data drop) Model UTP28X[X]**
2. Panduit Patch Cables (for Device End - 1 Per Data drop) Model UTP28X[X]**
3. Panduit 36" Patch Cables (for Surge Protection Device - 1 Per Data drop requiring surge protection) Model UTP6A3
4. Belden Patch Cables (for Data Room End - 1 Per Data drop) Small Diameter Patch Cords (where xxx equals footage length) Model CAD11006xxx
5. Belden Patch Cables (for Device End - 1 Per Data drop) Small Diameter Patch Cords (where xxx equals footage length) Model CAD11006xxx
6. Belden Patch Cables (for Surge Protection Device - 1 Per Data drop requiring surge protection) Small Diameter Patch Cords (where xxx equals footage length) Model CAD11006004
7. Ortronics Patch Cables (for Data Room End - 1 Per Data drop) Model OR-MC6A[xx]-06
8. Ortronics Patch Cables (for Device End - 1 Per Data drop) Model OR-MC6A[xx]-06
9. Ortronics 36" Patch Cables (for Surge Protection Device - 1 Per Data drop requiring surge protection) Model OR-MC6A03-03

C. Lengths:

1. Data room end Locations with Data Cabinets 3 foot ([x] = 3)
2. Data room end Locations with Data Racks 6 foot ([x] = 6)
3. Wireless access point device location 6 foot ([x] = 6)
4. Security Camera device location 6 foot ([x] = 6)
5. General Data outlet location 10 foot ([x] = 10)

D. Color:

1. General Use Data Blue
2. Wireless Access Points Blue
3. Security Cameras Orange

E. Additional Installation notes:

1. Contractor to establish proper wire management for patch cables from patch panels to switches. "Spider Webbing" with patch cables will not be accepted.
2. Patch cables shall not be shorter than 36".

2.8 DATA FACEPLATES

- A. Product Description: Single gang vertical faceplate accepts two to six Mini-Com® Modules, includes label pockets.
- B. Manufacturers:
1. Panduit Mini-Com Classic Series
 - a. Two Module Model CFPSL2S
 - b. Four Module Model CFPSL4S
 - c. Six Module Model CFPL6SY
 - d. Provide Blank Modules for all unused module spaces. Model CMBIG-X
 2. Belden: Compatible with REVConnect jacks.
 - a. Two Port White Model AX104231
 - b. Four Port White Model AX 104232
 - c. Six Port White Model AX 104233
 - d. Blank Inserts White Model AX 104456
 3. Ortronics HDJ Clarity Series
 - a. Two Module Model OR-403STJ12
 - b. Four Module Model OR-403STJ14
 - c. Six Module Model OR-40300457
 - d. Provide Blank Modules for all unused module spaces Model 4100002-87

2.9 DATA OUTLET BOXES

- A. Product Description: Shuttered surface mount box accepts up to two Modules.
- B. Manufacturers:
1. Panduit Mini-Com Shuttered Surface Mount Box Model CBX2IW-AY
 - a. For all above ceiling terminations and/or outlet locations.
 2. Belden Two-Port with Shuttered Door and ID Window Model AX102652
 - a. For all above ceiling terminations and/or outlet locations.
 3. Ortronics Clarity HDJ Surface Mount Boxes Model OR-PHAHJU48
 - a. For all above ceiling terminations and/or outlet locations.
- C. Mounting:
1. Panduit magnets to mount Surface Mount Boxes to structural steel or other permanent metal surface where possible. Model CBM-X
 2. Hook and Loop Cable ties may be used to mount Surface Mount Boxes where magnets cannot be used.
 3. Wall anchors may be used where the Surface Mount Box is located in an exposed area (such as gymnasium) AND there is no possible asbestos material.

2.10 DATA PATCH PANELS

- A. Product Description: TIA/EIA 568, rack-mounted assembly of terminals and accessory patch cords, with adequate capacity for active and spare circuits. 1RU. For all unused positions provide blank module.
- B. Manufacturers:
1. Panduit Mini-Com 48 Port HD Blank Patch Panel Model CPA48HDBL
 - a. Provide with each Patch Panel:
 - b. Strain Relief Bar Model SRB19BLY
 - 1) Panduit quick release brackets for SRB Model SRBBRKT
 2. Belden Modular Patch Panel Empty 48 port 1U Model AX103121
 - a. Belden strain relief bar is included with the patch panel.
 3. Ortronics Clarity HDJ 48 Port Patch Panel Model OR-PHAHJU48
 - a. Ortronics strain relief bar is included with the patch panel.
- C. Patch panel to be mounted at a minimum of 4 points.

2.11 SPEAKER CABLING

- A. Plenum Cable for Speaker Circuits: 18 AWG copper conductor, shielded, 2 conductor, and covered with a nonmetallic jacket; suitable for use for Class 2 circuits in air handling ducts, hollow spaces used as ducts, and plenums.
 - 1. Belden Part Number 6300FE

2.12 SUBSTITUTIONS

- A. Substitutions Allowed: None
- B. Contractor shall be responsible and assume all costs for removal and replacement of any substituted product installed without prior written approval. Such costs shall include, but not be limited to labor, materials as well as any penalties, fees or costs incurred for late completion.

2.13 SYSTEM DESIGN

- A. Provide a complete permanent end to end system of cabling and pathways for data communications, including but not limited to cables, conduits and wireways, pull wires, support structures, support devices, racks and cabinets, outlets, patch panels, and patch cables.
 - 1. Comply with TIA-568 (SET) (cabling) and TIA-569 (pathways) (commercial standards).
 - 2. Provide fixed cables and pathways that comply with NFPA 70 and TIA-607 and are UL listed or third party independent testing laboratory certified.
 - 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.
- B. Main Distribution Frame (MDF): Centrally located support structure for terminating horizontal cables that extend to telecommunications outlets, functioning as point of presence to external service provider.
 - 1. Locate main distribution frame as indicated on the drawings.
- C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
 - 1. Locate intermediate distribution frames as indicated on the drawings.
- D. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.14 GROUNDING AND BONDING COMPONENTS

- A. Comply with TIA-607.
- B. Comply with Section 27 05 26 - Grounding and Bonding For Communications Systems .

2.15 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606.
- B. Comply with 27 05 53 - Identification For Communications Systems.

2.16 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Factory test cables according to TIA-568 (SET).

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET) (cabling), TIA-569 (pathways), TIA-607 (grounding and bonding), BICSI N1, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. All Networks shall be installed per applicable standards and manufacturer's requirements.
- C. Comply with Communication Service Provider requirements.
- D. Grounding and Bonding: Perform in accordance with TIA-607 and NFPA 70.
- E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- F. Contractor must remove all abandoned cable per Article 800 of the National Electrical Code and per TIA and BICSI standards, recycling these materials where possible. Removal of orphaned cable is mandatory. Contractors must consider this when placing bids.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with 27 05 28 - Pathways For Communications Systems
- B. Outlet Boxes:
 - 1. Coordinate locations of outlet boxes provided under Section 26 05 33.16 as required for installation of telecommunications outlets provided under this section.
 - a. Mounting Heights: Unless otherwise indicated, as follows:
 - 1) Telephone and Data Outlets: 18 inches above finished floor.
 - 2) Telephone Outlets for Side-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.
 - 3) Telephone Outlets for Forward-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.
 - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
 - d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
 - e. Locate outlet boxes so that wall plate does not span different building finishes.
 - f. Locate outlet boxes so that wall plate does not cross masonry joints.
 - g. Outlet boxes shall be secured to building with mechanical fasteners. Adhesive fasteners are not allowed.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

- A. Copper Cabling:
 - 1. Use only type CMP plenum-rated cable, do not install below 32°F. If cable is stored below 32°F allow the cable to condition to room temperature 68°F as close to room temperature +/- 10°F 48 hours prior to installation.
 - 2. Horizontal distribution cables shall be bundled in groups of no more than manufacturers recommendations. Cable bundle quantities in excess of manufacturers recommendations may cause deformation of the bottom cables within the bundle and degrade cable performance.
 - 3. Maintain cable geometry; do not untwist more than .125 inch from point of termination.
 - 4. Any cable installed by the contractor exceeding 90 meters (295 feet) long must be replaced and routed to reduce length to 90 meters or less. Complete all cable re-routing at no additional cost to the Owner. Identify in writing to Architect/Engineer prior to installation of any cables that cannot be reduced to 90 meters or less in length.
 - 5. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.

COMMUNICATIONS COPPER CABLING

6. Do not pre pull cable out of box / reel prior to installing.
 7. Do not over-cinch or crush cables.
 8. Do not exceed manufacturer's recommended cable pull tension.
 9. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
 10. Protect from paint and other damaging contaminants. (any painted / contaminated cables shall be replaced at contractor's expense).
 11. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within room.
 12. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
 13. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits
 14. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the contractor shall install appropriate carriers to support the cabling.
 15. Install category 6,6A cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type.
 16. If cables have more than 12" of sag, install more hangers.
 17. Cables shall be installed in continuous lengths from origin to destination (no splices) except for transition points, or consolidation points.
 18. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
 19. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. Cabinet / Rack end: 10 feet
 2. Outlet end: 10 feet
 - a. At Distribution Frames: 10 feet.
 - b. At Outlets - Copper: 12 inches.
- C. Identification:
1. Use mechanically generated wire and cable markers to identify cables at each end.
 2. Use manufacturer-furnished label inserts, identification labels, or engraved wallplate to identify each jack at communications outlets with unique identifier.
 3. Use identification nameplate to identify cross-connection equipment, equipment racks, and cabinets.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Comply with inspection and testing requirements of specified installation standards.
- C. Visual Inspection:
 1. Inspect cable jackets for certification markings.
 2. Inspect cable terminations for color coded labels of proper type.
 3. Inspect outlet plates and patch panels for complete labels.
- D. Testing per 27 15 55 - Communications Cable Testing
- E. Labeling per 27 05 53 - Identification For Communications Systems
- F. Inspect patch cords for complete labels.
- G. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

- H. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

3.5 CLOSEOUT ACTIVITIES

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Provide manufacturer warranty documentation, ensure that forms have been completed in Owner's name, and registered with the manufacturer.
- C. Project Record Documents: Record actual locations and sizes of pathways, outlets, and jacks.
 - 1. Field Test Reports, one hard copy, one PDF copy and one software based copy (ex.: .FLW).

END OF SECTION

SECTION 27 11 16
COMMUNICATIONS CABINETS, RACKS, ENCLOSURES, & ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Communication Cabinets.
- B. Communication Racks.
- C. Wire Management.
- D. Uninterruptible Power Supplies.
- E. Power Distribution Units.

1.2 RELATED REQUIREMENTS

- A. Section 27 05 26 - Grounding and Bonding For Communications Systems.
- B. Section 27 05 28 - Pathways For Communications Systems.
- C. Section 27 05 53 - Identification For Communications Systems.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Storage and handling requirements and recommendations.
 - 2. Installation methods.
- C. Manufacturer Qualification Statement.
- D. Installers Qualification Statement.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 5 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Supervisors and installers factory certified by manufacturers of products to be installed.
 - 2. Employing BICSI Registered Cabling Installation Technicians (RCIT) for all work.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL

- A. All cabinet, racks, panels, and associated equipment shall comply with EIA/ECA-310 and TIA-606 standards.
- B. All cabinet, racks, panels, and associated equipment shall be properly grounded and bonded. See Section 27 05 26 - Grounding and Bonding For Communications Systems for related equipment and requirements.

2.2 COMMUNICATON CABINETS:

- A. 4' H x 30" D x 27.3" W Wall Mount Data Cabinet;
 - 1. Chatsworth CUBE-iT Plus Cabinet Model TS1024-670
 - a. Color- Black
 - b. Chatsworth Fan Kit Part No. 12804-701
 - 1) 100 CFM, 115 VAC
 - c. Panduit Horizontal Cable Manager (Provide 3) Model NMF2

- B. Locks: All locks in this project shall be keyed alike

2.3 COMMUNICATION RACKS:

- A. 2 Post Racks:
 - 1. 2 Post Universal Rack
 - a. CPI 19" EIA rack, aluminum (7') Model 46353-703
 - b. CPI Concrete Slab Install Kit Part No. 40604-003
 - 2. Refer to Section 27 05 26 for additional grounding and bonding components to provide with each rack.
- B. 4 Post Racks:
 - 1. QuadraRack 4 Post Frame
 - a. CPI 19" EIA rack, 30" D, bolted aluminum and steel (7') Model 50120-703
 - b. CPI Concrete Slab Install Kit Part No. 40604-003

2.4 WIRE MANAGEMENT

- A. Vertical Wire Managers:
 - 1. CPI 7' Double Sided Vertical Wire Management
 - a. 6 inch wide Model 35521-703
 - b. 8 inch wide Model 35522-703
 - c. 10 inch wide Model 35523-703
- B. Horizontal Wire Managers:
 - 1. CPI 2U Horizontal Wire Management Model 35441-702

2.5 UNINTERRUPTIBLE POWER SUPPLIES

- A. APC
 - 1. APC Smart-UPS 1500VA LCD RM 2U 120V Model SMT1500RM2UNC

2.6 POWER DISTRIBUTION UNITS (PDU'S)

- A. Horizontal PDU
 - 1. Panduit
 - a. Part No. P08D09M
 - b. Input Current: 15A.

- c. Input Plug Type: 5-15.
- d. Outlet Type: (8) 5-20R.
- e. Apparent Power: 1.4kVA.
- 2. Environmental Accessories (Provide with each PDU)
 - a. Panduit Temperature and Humidity Sensor
 - 1) Part No. EB001.

2.7 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
 - 1. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 - 2. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA-568 (SET), TIA-569, NECA/BICSI 607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.2 INSTALLATION OF EQUIPMENT

- A. Wall-Mounted Racks and Enclosures:
 - 1. Install to plywood backboards only, unless otherwise indicated.
- B. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements of specified installation standards.

END OF SECTION

SECTION 27 15 23
COMMUNICATIONS OPTICAL FIBER CABLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. System Design

1.2 REFERENCE STANDARDS

- A. EIA/ECA-310 - Cabinets, Racks, Panels, and Associated Equipment; 2005e.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. TIA/EIA-568 - Commercial Building Telecommunications Cabling Standard. (consists of 3 Parts, listed below); Rev C, 2012, and latest addenda.
- D. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 1988a (Reaffirmed 2012).
- E. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009a.
- F. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (Reaffirmed 2002).
- G. TIA-526-14 - Optical Power Loss Measurement of Installed Multimode Fiber Cable Plant; IEC 61280-4.1 Edition 3.1, Fiber Optic Communications Subsystem Test Procedures- Part 4-1: Installed Cable Plant- Multimode Attenuation Measurement; 2023d.
- H. TIA-526-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 Edition 2: Fibre-Optic Communications Subsystem Test Procedures – Part 4-2: Installed Cable Plant – Single-Mode Attenuation and Optical Return Loss Measurement; 2015a (Reaffirmed 2022).
- I. TIA-568.1 - Commercial Building Telecommunications Infrastructure Standard; 2020e.
- J. TIA-568.3 - Optical Fiber Cabling and Components Standard; 2022e.
- K. TIA-569 - Telecommunications Pathways and Spaces; 2019e, with Addendum (2022).
- L. TIA-606 - Administration Standard for Telecommunications Infrastructure; 2021d.
- M. TIA-607 - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises; 2019d, with Addendum (2021).
- N. UL 1863 - Communications-Circuit Accessories; Current Edition, Including All Revisions.
- O. UL 444 - Communications Cables; Current Edition, Including All Revisions.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate requirements for service entrance and entrance facilities with Communications Service Provider.
 - 2. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.

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3. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 4. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with Communications Service Provider representative.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used. The exact part numbers, colors and counts that are intended to be used shall be marked clearly on the submittal or it will be marked Revise and Re-Submit.
- C. Installer certification from the cable manufacturer MUST be submitted as part of the bid de-scoping process. The Certified Installer certificate cannot be site specific to this project and must be pre-existing for 12 months prior to the bid due date.
- D. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 60 days prior to intended test date.
- E. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
- F. Field Test Reports must be submitted bi-weekly to the construction manager that updates the status of each fiber optic cable installation, termination, testing and warranty.
- G. Project Record Documents shall be submitted at the conclusion of the project with the following information..
1. Record actual locations of cable routing, IDF locations, enclosures and panels.
 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 3. Fiber Test Results
 4. Warranty Information
 5. Operations & Maintenance Data
- H. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
1. Supervisors and installers factory certified by manufacturers of products to be installed.
 2. Employing experienced technicians for all work; show at least 3 years experience in the installation of the type of system specified, with evidence from at least 2 projects that have been in use for at least 18 months; submit project name, address, and written certification by user.
- C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

- E. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.
 - 1. Any violations of applicable standards or codes committed by the Contractor shall be remedied at the Contractor's expense.
- F. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to the approval of the Engineer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.
- C. System Warranty
 - 1. A Certification / System Warranty shall provide a complete system warranty to guarantee end-to-end high performance cabling systems that meet application requirements. The guarantee shall include all fiber optic connectivity components. The system shall be warranted for a period of a minimum of 20 years.

PART 2 PRODUCTS

2.1 SYSTEM DESIGN

- A. Provide a complete permanent fiber optic communication cabling system including cables, connectors, housings and support structures. The basis of design is 10GBase-T for all fiber optic links with additional 40GBase-T & 100GBase-T requirements for Single-Mode Fiber Optic LAN applications.
 - 1. Campus Backbone Cabling - Interconnection between campus buildings using OS2 fiber optic cabling.
 - 2. LAN Backbone Cabling - Interconnection between MDF & Multiple IDFs throughout the building using OM3/4 & OS2 fiber optic cabling.
 - 3. Service Entrance Fiber Optic Cabling
 - 4. Field Device Fiber Optic Cabling
- B. Main Distribution Frame (MDF): Centrally located support structure for terminating backbone cables, functioning as point of presence to external service provider.
 - 1. For the entire campus there is one main Network Operations Center (NOC) and for each building there is a main distribution frame (MDF) that functions as the central frame for that building. Locate main distribution frame as indicated on the drawings.
 - 2. Capacity: As required to terminate all cables required by design criteria plus minimum 25 percent spare space.
- C. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets. Locate intermediate distribution frames as indicated on the drawings.
- D. Backbone Cabling: Cabling, pathways, and terminal hardware connecting intermediate distribution frames (IDF's) with main distribution frame (MDF), wired in star topology with main distribution frame at center hub of star.

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- E. Fiber optic cabling not to exceed the max distance listed below to support 10 Gigabit transmission (including all patch cables).

Fiber Optic Type	Max Distance (Feet)	Max Distance (Meters)
OM3 Multimode	984	300
OM4 Multimode	1,312	400
OS2 Singlemode	32,808	10,000

2.2 SUBSTITUTIONS

- A. Section 01 60 00 - Product Requirements.
- B. This is a performance-based solution. Substitutions must follow the same rigid standards for quality and termination style as those described above.
- C. ANY CONTRACTOR WISHING TO OFFER FIBER OPTIC CABLING PRODUCTS OTHER THAN THOSE SPECIFIED HEREIN SHALL SUBMIT A REQUEST FOR PRODUCT SUBSTITUTION IN WRITING NO LESS THAN ONE WEEK IN ADVANCE OF BID. WRITTEN REQUESTS FOR SUBSTITUTION SHALL BE ACCOMPANIED BY ALL DRAWINGS, SPECIFICATION SHEETS AND ENGINEERING DOCUMENTS, AS WELL AS THIRD PARTY LABORATORY PERFORMANCE TEST RESULTS PROVING EQUIVALENCY IN PERFORMANCE AND MANUFACTURING STYLE.
- D. This written documentation shall be accompanied by samples of the substitution product offered for evaluation. Equal product acceptance must be received in writing.
- E. Contractor shall be responsible and assume all costs for removal and replacement of any substituted product installed without prior written approval. Such costs shall include, but not be limited to labor, materials as well as any penalties, fees or costs incurred for late completion.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with latest editions and addenda of TIA/EIA-568, TIA/EIA-569, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
- B. Comply with TIA-570, latest edition.
- C. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
- D. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
- E. Cabling terminations to follow industry standard color code as follows:
1. Blue
 2. Orange
 3. Green
 4. Brown
 5. Slate
 6. White
 7. Red
 8. Black
 9. Yellow
 10. Violet
 11. Rose
 12. Aqua
 13. Fiber 13 to 24: Repeated, but with a black tracer added (except for black, which has a white tracer).

- F. Contractor must remove all abandoned cable per Article 800 of the National Electrical Code and per TIA and BICSI standards, recycling these materials where possible. Removal of orphaned cable is mandatory. Contractors must consider this when placing bids.

3.2 PATHWAYS

- A. Install with the following minimum clearances:
1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 2. 12 inches from power conduits and cables and panelboards.
 3. 5 inches from fluorescent and high frequency lighting fixtures.
 4. 6 inches from flues, hot water pipes, and steam pipes.
- B. Conduit:
1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
 2. Leave pull cords in place where cables are not initially installed.
 3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
 - a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
 - b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.
 - c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
 - d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.
- C. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.
1. Conform to requirements as specified in 27 05 26 - Grounding and Bonding For Communications Systems.
 2. Where metallically shielded cables are used, grounding and bonding shall be accomplished by methods prescribed by the Engineer.
- D. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 07 84 00.

3.3 INSTALLATION OF CABLING

- A. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
1. At Distribution Frames: 120 inches.
- B. Fiber Optic Cabling:
1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 2. Support vertical cable at intervals as recommended by manufacturer.
 3. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
 4. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.
 - 5.
- C. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
1. Comply with requirements of 27 05 53 - Identification For Communications Systems.
 2. Cables: Install color coded labels on both ends.
 3. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.
 4. Patch Cords: Label with jack identifier corresponding to initial installation.

3.4 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements as specified in Section 27 15 55.
- B. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- C. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

3.5 CLOSEOUT ACTIVITIES

- A. See Section 01 70 00 - Execution and Closeout Requirements, for closeout procedures.
- B. Project Record Documents: Record actual locations and sizes of pathways, outlets, and jacks.
 - 1. Field Test Reports, one hard copy, one PDF copy and one software based copy (ex.: .FLW).

END OF SECTION

SECTION 27 15 55
COMMUNICATIONS CABLE TESTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Provide all labor, materials, tools, equipment, and field-test instruments required for the complete testing, identification and administration of the work called for in the Contract Documents.
- B. To conform to the overall project schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.
- C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.
- D. Minimum requirements for the test certification, identification and administration of backbone and horizontal optical fiber cabling.
 - 1. Category 6 Copper Cabling.
 - 2. Multimode Fiber Cabling.
 - 3. Single-Mode Fiber Cabling.

1.2 RELATED REQUIREMENTS

- A. Section 27 10 05 - Communications Copper Cabling
- B. Section 27 15 23 - Communications Optical Fiber Cabling

1.3 REFERENCE STANDARDS

- A. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 2012.
- B. TIA-492AAAA-B - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.
- C. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.
- D. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).
- E. TIA/EIA-568-C.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev C, 2012; Addenda 1-7.
- F. TIA/EIA-568-C.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev C, 2012; Addenda 1-11.
- G. TIA/EIA-568-C.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables
- H. ANSI/TIA/EIA 455 61A, Measurement of Fiber or Cable Attenuation Using an OTDR.
- I. ANSI/TIA/EIA-455-59A, Measurement of Fiber Point Discontinuities Using an OTDR.
- J. ANSI/TIA/EIA 455 60A, Measurement of Fiber or Cable Length Using an OTDR.

- K. ANSI Z136.2, ANS for Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources.
- L. ANSI/TIA/EIA 526 7, Optical Power Loss Measurements of Installed Singlemode Fiber Cable Plant.
- M. ANSI/EIA/TIA 455 50B, Light Launch Conditions For Long-Length Graded-Index Optical Fiber Spectral Attenuation Measurements
- N. ANSI/TIA 526 14 B, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; IEC 61280-4-1 edition 2, Fiber Optic Communications Subsystem Test Procedure- Part 4-1: Installed cable plant- Multimode attenuation measurement.
- O. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.

1.4 SUBMITTALS

- A. Manufacturers catalog sheets and specifications for fiber optic and copper field-test instruments.
- B. Sample test reports.
- C. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

1.5 QUALITY ASSURANCE

- A. Installer / Tester Qualifications:
 - 1. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi or the ACP (Association of Cabling Professionals).
 - a. Manufacturer of the copper cable and copper connectors, manufacturer of the fiber optic cable and/or the fiber optic connectors.
 - b. Manufacturer of the test equipment used for the field certification.
- B. Testing Equipment Qualifications:
 - 1. Field test instruments shall comply with the accuracy requirements for level III field testers as defined in ANSI/TIA-1152. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in Table 3 of ANSI/TIA-1152 (Table 3 in this TIA document also specifies the accuracy requirements for the Channel configuration).
 - 2. Field-test instruments shall have the latest software and firmware installed.
 - 3. Field-test instruments (tester) shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
 - 4. The RJ45 test plug shall fall within the values specified in ANSI/TIA-568-C Annex C for NEXT, FEXT and Return Loss.
 - 5. Testing of the fiber cabling shall be performed using high-quality test cords of the same fiber type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.
 - 6. The copper tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.
 - 7. Field-test instruments (tester) shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

8. Field-test instruments shall have the latest software and firmware installed.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 COPPER

- A. Every cabling link in the installation shall be tested in accordance with the field test specifications defined in ANSI/TIA-568-C.2 "Commercial Balanced Twisted-Pair Telecommunications Cabling and Components Standard". This document will be referred to as the "Category 6 Standard."
- B. Every cabling link in the installation shall be tested for the following:
 1. Wire Map
 2. Length
 3. Insertion Loss
 4. NEXT Loss
 5. PS NEXT Loss
 6. ACR-F Loss
 7. PS ACR-F Loss
 8. Return Loss
 9. Propagation Delay
 10. Delay Skew
 11. DC Resistance Unbalance.
- C. The cable type must be set to match the cable manufacturer and type installed, do not set to the default Cat 6 UTP. If the manufacturer of the cable installed is not listed in the field test equipment, only then, the default Cat 6 UTP may be used.
- D. The location of the "Main" shall be at the MDF or IDF and the location of the "Remote" shall be at the outlet. If the location of the "Main" and "Remote" are reversed, it must be noted in the test report documentation for any and all instances.
- E. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification as defined in the Category 6 Standard.
- F. One hundred percent of the installed cabling links must pass the requirements of the Category 6 Standard and as further detailed in this Section. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with this Section.
- G. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk " * " when the result is closer to the test limit than the accuracy of the field tester. The field tester manufacturer must provide documentation as an aid to interpret results marked with asterisks. To which extent " * " results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.
- H. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Section 4.2.2 of ANSI/TIA-1152). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass*.

3.2 FIBER

- A. Every fiber cable link shall be tested in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fiber end faces shall also be verified.
- B. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- C. All tests performed on optical fiber cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.
- D. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.
- E. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC in which the administrative documentation (reports) may be generated.
- F. Fiber end faces shall be inspected at x200 or x400 magnification. x200 magnification is suitable for inspecting multimode and singlemode fibers. x400 magnification may be used for detailed examination of singlemode fibers. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
 - 1. End face images shall be recorded in the memory of the test instrument for subsequent uploading to a PC and reporting.
- G. Testing shall be performed on each cabling segment (connector to connector).
- H. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
- I. Optical loss testing - Horizontal / Backbone link
 - 1. Multimode links shall be tested at 850 nm and 1300 nm in accordance with ANSI/TIA-526-14-B, one-cord reference method.
 - 2. Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7, Method A.1, One Reference Jumper equivalent method.
 - 3. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- J. OTDR Testing
 - 1. Fiber links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
 - a. Multimode: 850 nm and 1300 nm
 - b. Singlemode: 1310 nm and 1550 nm
 - 2. Each fiber link and channel shall be tested in both directions.
 - 3. A launch cable shall be installed between the OTDR and the first link connection.
 - 4. A receive cable shall be installed after the last link connection.
- K. Length Measurement
 - 1. The length of each fiber shall be recorded.
 - 2. It is preferable that the optical length be measured using an OLTS or OTDR.
- L. Polarity Testing
 - 1. Paired duplex fibers in multi-fiber cables shall be tested to verify polarity in accordance with Clause E.5.3 of ANSI/TIA 568 C.0. The polarity of the paired duplex fibers shall be verified using an OLTS.

3.3 DOCUMENTATION

- A. The test results / measurements saved within the field test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. A guarantee shall be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the field test instrument” at the end of each test and that these results cannot be modified at a later time. The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
- B. The test results documentation shall be available for inspection by the Owner or the Owner’s representative during the installation period and shall be passed to the Owner’s representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.
- C. The database for the completed job shall be stored and delivered on CD-ROM or DVD prior to Owner acceptance. This CD-ROM or DVD shall include the software tools required to view, inspect, and print any selection of test reports.
- D. Circuit IDs reported by the test instrument should match the specified label ID.
- E. Detailed test result documentation shall be provided in an electronic data base and shall include the following information for each link:
 - 1. Identification of the customer site as specified by the owner.
 - 2. Identification of the link in accordance with the naming convention defined in the overall system documentation.
 - 3. The name of the test limit selected to execute the stored test results.
 - 4. The name of the personnel performing the test.
 - 5. The overall Pass/Fail evaluation of the link-under-test.
 - a. Including the NEXT Headroom (overall worst case) number for copper.
 - b. Including OLTS and OTDR measurements for fiber.
 - 6. Identification of the tester interface.
 - 7. Date and time the test results were saved in the memory of the tester.
 - 8. The manufacturer, model and serial number of the field-test instrument.
 - 9. The version of the test software and the version of the test limit database held within the test instrument
 - 10. Test results information must contain information on each of the required test parameters that are listed in this Section and as further detailed below.
- F. Copper
 - 1. Detailed test results data to be provided in the electronic database for must contain the following information:
 - a. For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a color graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as outlined above for each of the test parameters.
 - 1) Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1) and the test limit value.
 - 2) Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value.
 - 3) Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value.
 - 4) Insertion Loss (Attenuation): Minimum test results documentation as explained in this Section for the worst pair.
 - 5) Return Loss: Minimum test results documentation as explained in this Section for the worst pair as measured from each end of the link.
 - 6) NEXT, ACR-F: Minimum test results documentation as explained in this Section for the worst pair combination as measured from each end of the link.
 - 7) PS NEXT and PS ACR-F: Minimum test results documentation as explained in this Section for the worst pair as measured from each end of the link.

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- 8) DC Resistance Unbalance.
 - b. Cable type and the value of NVP used for length calculations.
- G. Fiber
- 1. Detailed test results data to be provided in the electronic database for must contain the following information:
 - a. The fiber identification number.
 - b. The length for each optical fiber.
 - c. The length for each optical fiber as calculated by the OTDR.
 - d. Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
 - e. Test results to include OLTS attenuation link and channel measurements at the appropriate wavelength(s) and the margin (difference between the measured attenuation and the test limit value).
 - f. End face inspection images.

3.4 FIELD QUALITY CONTROL

- A. A representative of the owner shall reserve the right to be invited to witness field testing. The representative shall be notified of the start date of the testing phase five business days before testing commences.
- B. A representative of the owner shall reserve the right to select a random sample of 5% of the installed links. The representative (or his / her authorized delegate) shall test these randomly selected links and the results are to be stored in accordance with the prescriptions in this Section. The results obtained shall be compared to the data provided by the installation contractor. If more than 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the end-user representative shall repeat 100% testing and the cost shall be borne by the installation contractor.

END OF SECTION

SECTION 27 41 00
AUDIO - VIDEO SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Classroom Audio/Video Cabling
- B. Audio/Video System Patch Cables
- C. Audio/Video Interface Faceplate & Connectivity
- D. Audio/Video Racks & Enclosure
- E. Classroom Interactive Display
- F. Classroom Display Mounts & Backers
- G. Grounding and bonding for Audio/Video Systems.
- H. Assistive Listening Device
- I. Digital Signage Monitor
- J. Digital Signage Mounting Hardware

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 27 05 26 - Grounding and Bonding for Communications Systems.
- C. Section 27 05 28 - Pathways for Communications Systems.
- D. Section 27 05 53 - Identification for Communications Systems.
- E. Section 27 15 55 - Communications Cable Testing.

1.3 REFERENCE STANDARDS

- A. EIA-310 - Cabinets, Racks, Panels, and Associated Equipment; Electronic Industries Association; Revision D, 1992.
- B. CEA-310 - Cabinets, Racks, Panels, and Associated Equipment; Consumer Electronics Association; Revision E, 2005.
- C. ICEA S-90-661 - Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without An Overall Shield) For Use in General Purpose and LAN Communications Wiring Systems Technical Requirements; Insulated Cable Engineers Asso
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. TIA-455-21 - FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices; 2012.
- F. TIA-492AAAA-B - Detail Specification for 62.5-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.

- G. TIA-492AAAB-A - Detail Specification for 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers; 2009.
- H. TIA-492CAAA - Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers; 1998 (R 2002).
- I. TIA-526-7 - OFSTP-7 - Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant; 2002.
- J. TIA-526-14 - OFSTP-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant; Rev B, 2010.
- K. TIA/EIA-568-C.1 - Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements; Rev C, 2012; Addenda 1-7.
- L. TIA/EIA-568-C.2 - Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted Pair Cabling Components; Rev C, 2012; Addenda 1-11.
- M. TIA/EIA-568-C.3 - Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling Components Standard, and Addendum 1 - Additional Transmission Performance Specifications for 50/125 um Optical Fiber Cables
- N. TIA-569 - Commercial Building Standard for Telecommunications Pathways and Spaces; 2012.
- O. TIA-570 - Residential Telecommunications Infrastructure Standard; 2012.
- P. TIA/EIA-606 - Administration Standard for the Telecommunications Infrastructure; Rev B, 2012.
- Q. ANSI/J-STD-607 - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications; Rev A, 2002.
- R. UL 444 - Communications Cables; Current Edition, Including All Revisions.
- S. UL 497 - Standard for Protectors for Paired-Conductor Communications Circuits; Current Edition, Including All Revisions.
- T. UL 514C - Standard for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers; Current Edition, Including All Revisions.
- U. UL 1581 - Reference Standard for Electrical Wires, Cables, and Flexible Cords; Current Edition, Including All Revisions.
- V. UL 1863 - Standard for Communications-Circuit Accessories; Current Edition, Including All Revisions.
- W. USDA RUS 345-83 - Gas Tube Surge Arrestors (PE-80); US Department of Agriculture; 1982.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for Audio/Video equipment.
 - 2. Coordinate arrangement of Audio/Video equipment with the dimensions and clearance requirements of the actual equipment to be installed.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Preinstallation Meeting: Convene one week prior to commencing work of this section to review service requirements and details with the Construction Management representative.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturers installation instructions.
 - 2. Storage and handling requirements and recommendations.
 - 3. Part numbers.
 - 4. Notes to clarify any part number choices on product sheet.
 - 5. Installation methods.
- C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding.
- D. Manufacturer Qualifications.
- E. Installer Qualifications.
- F. Test Plan: Complete and detailed plan, with list of test equipment, procedures for inspection and testing, and intended test date; submit at least 30 Days prior to intended test date.
- G. Field Test Reports.
- H. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
 - 1. Record actual locations of outlet boxes and distribution frames.
 - 2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
 - 3. Identify distribution frames and equipment rooms by room number on contract drawings.
- I. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of project record documents.

1.6 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations and sizes of pathways and outlets.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
- B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
 - 1. Employing a BICSI Registered Communications Distribution Designer (RCDD).
 - 2. Supervisors and installers factory certified by manufacturers of products to be installed.
 - 3. Employing BICSI Registered Cabling Installation Technicians (RCIT) for all work.
 - 4. Employing experienced technicians for all work; show at least 3 years experience in the installation of the type of system specified, with evidence from at least 2 projects that have been in use for at least 18 months; submit project name, address, and written certification by user.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Keep stored products clean and dry.

1.9 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a 2 year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Cabling:

1. Verify all cable lengths required for installation in field
 2. HDMI Rapid Run
 - a. 15' HDMI Optical Runner Plenum Rated Rapid Run Part # 60177
 - b. 35' HDMI Optical Runner Plenum Rated Rapid Run Part # 60118
 - c. 50' HDMI Optical Runner Plenum Rated Rapid Run Part # 60119
 - d. 65' HDMI Optical Runner Plenum Rated Rapid Run Part # 60120
 - e. 80' HDMI Optical Runner Plenum Rated Rapid Run Part # 60121
 - f. 100' HDMI Optical Runner Plenum Rated Rapid Run Part # 60122
 - g. 125' HDMI Optical Runner Plenum Rated Rapid Run Part # 60123
 - h. HDMI Receiver Flying Lead Rapid Run Part # 60131
 - i. HDMI Wall Plate Transmitter Rapid Run Part # 60150
 3. VGA, Composite, 3.5mm Audio Rapid Run
 - a. 15' Multi-Format Runner CMG Rated Rapid Run Part # 60002
 - b. 35' Multi-Format Runner CMG Rated Rapid Run Part # 60004
 - c. 50' Multi-Format Runner CMG Rated Rapid Run Part # 60005
 - d. 75' Multi-Format Runner CMG Rated Rapid Run Part # 60006
 - e. 100' Multi-Format Runner CMG Rated Rapid Run Part # 60007
 - f. 125' Multi-Format Runner CMG Rated Rapid Run Part # 60008
 - g. VGA, 3.5mm, Composite Video Lead 1.5' Rapid Run Part # 60018
 - h. Double Gang Integrated VGA & 3.5mm & Composite Video & Stereo Audio Wall Plate Rapid Run Part # 60041
 4. HDMI
 - a. 3 Meter (9.84 Foot) On-Q Part # AC2M03-BK
 - b. 4 Meter (13.12 Foot) On-Q Part # AC2M04-BK
 - c. 5 Meter (16.40 Foot) On-Q Part # AC2M05-BK
 - d. 7.5 Meter (24.60 Foot) On-Q Part # AC2M07-BK
 - e. 10 Meter (32.80 Foot) On-Q Part # AC2M10-BK
 - f. 15 Meter (49.21 Foot) On-Q Part # AC2M15-BK
 - g. 20 Meter (65.61 Foot) On-Q Part # AC2M20-BK
 - h. HDMI repeater On-Q Part# AC2100-V1
 - 1) HDMI Repeater is required for any cable distance beyond 50 feet (use 2 cables with the repeater installed as a coupler between them).
 5. SXGA
 - a. 35 Foot CMG-Rated HD15 SXGA Male / Male Monitor / Projector Cable with rounded, low profile connectors. Cables To Go Product # 40127
 - b. 50 Foot CMG-Rated HD15 SXGA Male / Male Monitor / Projector Cable with rounded, low profile connectors. Cables To Go Product # 40128
 - c. 75 Foot CMG-Rated HD15 SXGA Male / Male Monitor / Projector Cable with rounded, low profile connectors. Cables To Go Product # 40129
 6. 3.5mm Stereo Audio
 - a. 35 Foot 22 AWG shielded Male / Male 3.5 mm Stereo Audio Cable with gold plated connectors. Monoprice Product ID # 5582
 - b. 50 Foot 22 AWG shielded Male / Male 3.5 mm Stereo Audio Cable with gold plated connectors. Monoprice Product ID # 5583
 - c. 75 Foot 22 AWG shielded Male / Male 3.5 mm Stereo Audio Cable with gold plated connectors. Monoprice Product ID # 5582
- #### B. A/V Workstation Modules for use with Wiremold Raceway
1. Series II Keystone Adapter Ortronics Part # OR-KSS2210-99
 2. Series II 15 Pin VGA Fem. / Fem. Ortronics Part # OR-60900376-99
 3. Series II 19 Pin HDMI Fem. / Fem. Ortronics Part # OR-60900372-99
 4. Series II Blank Module, 1 Unit Ortronics Part # OR-40300164-99

5. Keystone 19 Pin HDMI Fem. / Fem. Ortronics Part # OR-KSHDMI-99
6. Keystone 3.5mm Stereo Fem. / Fem. Ortronics Part # OR-KS35ST-99
7. Keystone Blank (10 Pack) Ortronics Part # OR-KSB10-99
8. Panduit Netkey Cat. 6 Keystone Jack Module to be used only with Wiremold raceway Applications Panduit Part # NK688Mxx (replace xx with color code)

C. Wiremold 5400 Raceway Components

1. Base with 2 channels Wiremold Part # 5400TB
2. Full-Width Raceway Cover (both channels) Wiremold Part # 5400C
3. Twin Snap Raceway Cover (single channel) Wiremold Part # 5400TC
4. Twin Snap Cover Wire Clip Wiremold Part # 5400TWC
5. Full-Width Cover Clip (both channels) Wiremold Part # 5406A
6. Twin Cover Clip (single channel) Wiremold Part # 5406T
7. Blank End Fitting Wiremold Part # 5410
8. Base Seam Clip Wiremold Part # 5406TB
9. Radiused Full Capacity Flat Elbow Wiremold Part # 5411FO
10. Radiused Full Capacity Tee Wiremold Part # 5415FO
11. Radiused Full Capacity Internal Elbow Wiremold Part # 5417FO
12. Radiused Full Capacity External Elbow Wiremold Part # 5418FO
13. External Elbow (if space is limited) Wiremold Part # 5418
14. Device Bracket (both channels) Wiremold Part # 5450
15. Twin Snap Device Bracket (single Channel) Wiremold Part # 5450T
16. Angled Raceway Adapter (fits 2 Ortronics Series II Modules) Wiremold Part # ARA-S2

D. A/V Workstation Modules

1. Mini-Com 15 Pin VGA Fem. / Fem. Panduit Part # CHD9CIWY
2. Mini-Com 19 Pin HDMI Fem. / Fem. Panduit Part # CMHDMIW
3. Mini-Com 3.5mm Stereo Fem. / Fem. Panduit Part # CM35MSCIWY
4. Mini-Com 2 Module Insert Panduit Part # CHF2MIW-X
5. Mini-Com 1/3 Blank Insert Panduit Part # CHB2MIW-X
6. Mini-Com Single Module Blank Insert Panduit Part # CMBIW-X
7. Mini-Com Banana (Red) Panduit Part # CMBPREIY
8. Mini-Com Banana (Black) Panduit Part # CMBPBEIY

E. Over the Board Mounts for Eno Boards

1. Provide 1 kit per Eno Classic 2610 M&B Machine Inc. Part # OBM-100-96 ENO
2. Provide 1.5 kits per Eno Classic 2810 M&B Machine Inc. Part # OBM-100-96 ENO
3. Provide 2 kits per Eno Flex M&B Machine Inc. Part # OBM-100-96 ENO
4. Extended Length Mount (up to 84") M&B Machine Inc. Part # OBM-100-LONG-ENO

F. Substitutions

1. Section 01 60 00 - Product Requirements.

2.2 ASSISTED LISTENING

- A. All assisted listening active equipment for the project shall be purchased by the owner and turned over to the electrical contractor for installation. The electrical contractor shall be responsible to provide the services to develop the assisted listening system documentation, equipment installation, wire, wire terminations, back boxes, face plates, conduit, wire-mold, fasteners, common installation material and commissioning such that the project has a complete and workable assisted listening system compliant with section 27 41 00.

- B. Provide Labor, material, equipment, services for a complete installation, startup, and commissioning of the assisted listening wiring as required in contract documents. Provide wiring, conduit, wire terminations, back boxes, wire-mold, fasteners, and common installation material required to connect devices furnished as part of, or integral to the assisted listening system regardless of the source of supply. Provide all wiring and terminations for the assisted listening system in accordance to the specification and detailed engineered drawings provided by factory representative. Provide all assembly and testing of all items as necessary to create a coherent system, encompassing all combined intents of design, drawings, specifications, addenda, and professional quality of work.

- C. See the project responsibility matrix below:
EC - Prime Electrical contractor
Owner - Project Owner
Integrator - Systems Integrator

<u>PRODUCTS</u>	<u>PROVIDED BY</u>	<u>INSTALLED BY</u>	<u>WIRING BY</u>	<u>COMMISSIONED BY</u>
ASSISTED LISTENING CONTROLLER & MICS	OWNER	EC	EC	INTEGRATOR
ASSISTED LISTENING SPEAKERS	OWNER	EC	EC	INTEGRATOR
ASSISTED LISTENING IR SENSORS	OWNER	EC	EC	INTEGRATOR
ASSISTED LISTENING SPEAKER WIRING BELDEN PART# 6300FE	EC	EC	EC	INTEGRATOR
ASSISTED LISTENING WALL PLATE PANDUIT PART# CFPE10IW-2GY	EC	EC	EC	INTEGRATOR
RCA PASS THROUGH PANDUIT PART# CMRPBIW	EC	EC	EC	INTEGRATOR
BAS CONNECTOR PANDUIT PART# CMBRS485BU	EC	EC	EC	INTEGRATOR
ASSISTED LISTENING INTERCONNECT CABLES	OWNER	EC	EC	INTEGRATOR

2.3 SYSTEM DESIGN

- A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
1. Comply with TIA/EIA-568 and TIA/EIA-569, latest editions.
 2. Provide fixed cables and pathways that comply with NFPA 70 and ANSI/J-STD-607 and are UL listed or third party independent testing laboratory certified.
 3. Provide connection devices that are rated for operation under conditions of 32 to 140 degrees F at relative humidity of 0 to 95 percent, noncondensing.
 4. In this project, the term plenum is defined as return air spaces above ceilings, inside ducts, under raised floors, and other air-handling spaces.

- B. Intermediate Distribution Frames (IDF): Support structures for terminating horizontal cables that extend to telecommunications outlets.
 - 1. Locate intermediate distribution frames as indicated on the drawings.
- C. Cabling to Outlets: Specified horizontal cabling, wired in star topology to distribution frame located at center hub of star; also referred to as "links".

2.4 A/V ENCLOSURES

- A. Backboards: Interior grade plywood without voids, 3/4 inch thick; UL-labeled fire-retardant.
 - 1. Size: 48 inches wide by 96 inches high.
 - 2. Size: As indicated on drawings.
 - 3. Do not paint over UL label.
- B. Equipment Racks and Cabinets: CEA-310 standard 19 inch wide component racks.
 - 1. Wall Mounted Racks: 8 gage aluminum brackets, hinged to allow access to back of installed components.
 - 2. Floor Mounted Racks: 16 gage steel construction with corrosion resistant finish; vertical and horizontal cable management channels, top and bottom cable troughs, and grounding lug.
 - 3. Freestanding Cabinets: Front and rear doors with locks; removable side panels with locks; vented top and rear door; adjustable leveling feet; cable access in roof and base; grounding bar.
 - 4. Wall Mounted Cabinets: Front doors with locks, louvered side panels, top and bottom cable access, and ground lug.
 - a. Cover inside of cabinet back with plywood backboard as specified.
 - b. Duplex AC power outlet inside cabinet.
 - 5. Cabinets: 16 gage steel construction with corrosion resistant finish.
 - 6. Locks: Keyed alike.
- C. Building Entrance Protector: Factory fabricated panel to connect incoming cable and interior cable to protector modules.
 - 1. Capacity: One protector module per pair in incoming cable.
 - 2. Protector Modules: Type rated for the application.
 - a. Solid State Type: Complying with UL 497.
 - b. Gas Tube Type: Three electrode; complying with USDA RUS 345-83.
 - 3. Incoming Side: Provide connector blocks of type specified.
 - 4. Outgoing Side (to Interior): Backbone cable wired to connector blocks.
 - a. Provide steel enclosure with lockable door.
 - b. Provide a single enclosure for ganged panels.
- D. Outlet Boxes: For flush mounting in walls; depth as required to accommodate cable manufacturer's recommended minimum conductor bend radius.
 - 1. Size, Unless Otherwise Indicated: 4 inches square by 2-1/8 inches deep.
 - 2. Wall-Mounted Telephones: 4 inches high by 2 inches wide by 2-1/8 inches deep.
 - 3. Boxes for Fiber Optic Outlets: Single or two gang as indicated.
 - a. Size: 4-11/16 inches square by 2-1/8 inches deep.
 - 4. Wall Plates: Material and finish to match wiring device and wall plate finishes specified in Section 26 27 26, complying with system design standards and UL 514C.
 - 5. Labels: Comply with TIA/EIA-606 using encoded identifiers; label each jack on the face plate as to its function with a unique numerical identifier.

2.5 DIGITAL SIGNAGE

- A. DISPLAY
 - 1. Product Requirements
 - a. Viewable Image Size 40"
 - b. Native Resolution 1920 x 1080
 - c. Backlight Type LED Edge-lit
 - d. Contrast Ratio 4000:1

- e. Viewing Angle 178° Vert., 178° Hor.
- f. Response Time(Gray to Gray) 8ms
- g. Refresh Rate 60Hz
- h. Aspect Ratio 16:9
- i. Orientation Landscape/Portrait
- j. Displayable Colors More than 16.7 million
- k. VESA 300 x 300mm (4-hole)
- 2. Approved Products
 - a. NEC Model: P403

B. PORTRAIT MOUNT

- 1. Product Requirements
 - a. Single Stud Mounting
 - b. Color Black
 - c. Orientation Landscape, Portrait
 - d. Tilt +2°, -12°
 - e. Weight Capacity 75 lbs (34 kg)
- 2. Approved Products
 - a. Chief Model: MTMS1U

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with all manufacturer's installation instructions for all components being installed.
 - 1. Any installation that does not comply with manufacturer's installation instructions must be approved by engineer prior to installation.
- B. Eno Boards, Projectors, and Speaker Systems
 - 1. Contractor shall install all components required for a complete system installation including the aiming and adjusting of the projector image to match the screen size.
 - a. Comply with latest editions and addenda of TIA/EIA-568, TIA/EIA-569, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.
 - b. Comply with latest editions and addenda of TIA-570, ANSI/J-STD-607, NFPA 70, and SYSTEM DESIGN as specified in PART 2.

3.2 PATHWAYS

- A. Underground Service Entrance: Install conduit at least 18 inches below finish grade; encase in at least 3 inches thick concrete for at least 60 inches out from the building line.
- B. Install with the following minimum clearances:
 - 1. 48 inches from motors, generators, frequency converters, transformers, x-ray equipment, and uninterruptible power systems.
 - 2. 12 inches from power conduits and cables and panelboards.
 - 3. 5 inches from fluorescent and high frequency lighting fixtures.
 - 4. 6 inches from flues, hot water pipes, and steam pipes.
- C. Conduit:
 - 1. Do not install more than 2 (two) 90 degree bends in a single horizontal cable run.
 - 2. Leave pull cords in place where cables are not initially installed.
 - 3. Conceal conduit under floor slabs and within finished walls, ceilings, and floors except where specifically indicated to be exposed.
 - a. Conduit may remain exposed to view in mechanical rooms, electrical rooms, and telecommunications rooms.
 - b. Treat conduit in crawl spaces and under floor slabs as if exposed to view.

- c. Where exposed to view, install parallel with or at right angles to ceilings, walls, and structural members.
 - d. Under floor slabs, locate conduit at 12 inches, minimum, below vapor retarder; seal penetrations of vapor retarder around conduit.
- D. Outlet Boxes:
 - 1. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of telecommunications outlets provided under this section.
 - a. Mounting Heights: Unless otherwise indicated, as follows:
 - 1) Telephone and Data Outlets: 18 inches above finished floor.
 - 2) Telephone Outlets for Side-Reach Wall-Mounted Telephones: 54 inches above finished floor to top of telephone.
 - 3) Telephone Outlets for Forward-Reach Wall-Mounted Telephones: 48 inches above finished floor to top of telephone.
 - b. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
 - c. Provide minimum of 24 inches horizontal separation between flush mounted outlet boxes installed on opposite sides of fire rated walls.
 - d. Unless otherwise indicated, provide separate outlet boxes for line voltage and low voltage devices.
 - e. Locate outlet boxes so that wall plate does not span different building finishes.
 - f. Locate outlet boxes so that wall plate does not cross masonry joints.
- E. Grounding and Bonding: Perform in accordance with ANSI/J-STD-607 and NFPA 70.
- F. Firestopping: Seal openings around pathway penetrations through fire-rated walls, partitions, floors, and ceilings in accordance with Section 07 84 00.

3.3 INSTALLATION OF EQUIPMENT AND CABLING

- A. Cabling:
 - 1. Provide wire clips from same manufacturer as raceway used for all raceway installations.
 - 2. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
 - 3. Do not over-cinch or crush cables.
 - 4. Do not exceed manufacturer's recommended cable pull tension.
 - 5. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
- B. Service Loops (Slack or Excess Length): Provide the following minimum extra length of cable, looped neatly:
 - 1. At Distribution Frames: 120 inches.
 - 2. At Outlets - Copper: 12 inches.
 - 3. At Outlets - Optical Fiber: 39 inches.
- C. Copper Cabling:
 - 1. Category 5e/6: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
 - 2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
 - 3. Copper Cabling Not in Conduit: Use only type CMP plenum-rated cable as specified.
- D. Fiber Optic Cabling:
 - 1. Prepare for pulling by cutting outer jacket for 10 inches from end, leaving strength members exposed. Twist strength members together and attach to pulling eye.
 - 2. Support vertical cable at intervals as recommended by manufacturer.
- E. Wall-Mounted Racks and Enclosures:
 - 1. Install to plywood backboards only, unless otherwise indicated.
 - 2. Mount so height of topmost panel does not exceed 78 inches above floor.

- F. Floor-Mounted Racks and Enclosures: Permanently anchor to floor in accordance with manufacturer's recommendations.
- G. Floor-Mounted Enclosures: Connect adjacent cabinets together and remove interior side panels.
- H. Field-Installed Labels: Comply with TIA/EIA-606 using encoded identifiers.
 - 1. Cables: Install color coded labels on both ends.
 - 2. Outlets: Label each jack on its face plate as to its type and function, with a unique numerical identifier.
 - 3. Patch Panels: Label each jack as to its type and function, with a unique numerical identifier.
 - 4. Patch Cords: Label with jack identifier corresponding to initial installation.

3.4 FIELD QUALITY CONTROL

- A. Comply with inspection and testing requirements of specified installation standards.
- B. Visual Inspection:
 - 1. Inspect cable jackets for certification markings.
 - 2. Inspect cable terminations for color coded labels of proper type.
 - 3. Inspect outlet plates and patch panels for complete labels.
 - 4. Inspect patch cords for complete labels.
- C. Testing - Copper Cabling and Associated Equipment:
 - 1. Test backbone cables after termination but before cross-connection.
 - 2. Test backbone cables for DC loop resistance, shorts, opens, intermittent faults, and polarity between connectors and between conductors and shield, if cable has overall shield.
 - 3. Test operation of shorting bars in connection blocks.
 - 4. Category 3 Backbone: Perform attenuation test.
 - 5. Category 3 Links: Test each pair for short circuit continuity, short to ground, crosses, reversed polarity, operational and ring-back, and dial tone.
 - 6. Category 5e/6 Backbone: Perform near end cross talk (NEXT) and attenuation tests.
 - 7. Category 5e/6 Links: Perform tests for wire map, length, attenuation, NEXT, and propagation delay.
- D. Testing - Fiber Optic Cabling:
 - 1. Backbone: Perform optical fiber end-to-end attenuation test using an optical time domain reflectometer (OTDR) and manufacturer's recommended test procedures; perform verification acceptance tests and factory reel tests.
 - 2. Multimode Backbone: Perform tests in accordance with TIA/EIA-526-14 Method B.
 - 3. Single Mode Backbone: Perform tests in accordance with TIA-526-7 Method B.
 - 4. Links: Perform optical fiber end-to-end attenuation tests and field reel tests.
- E. Final Testing: After all work is complete, including installation of telecommunications outlets, and telephone dial tone service is active, test each voice jack for dial tone.

END OF SECTION

SECTION 28 10 00
ACCESS CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Access control system requirements.
- B. Access control units and software.
- C. Access control point peripherals, including readers.
- D. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 08 71 00 - Door Hardware.
 - 1. Includes door hardware with integral request to exit devices.
- C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- E. Section 26 05 33.13 - Conduit for Electrical Systems.
- F. Section 26 05 33.16 - Boxes for Electrical Systems.
- G. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
- H. Section 27 05 26 - Grounding and Bonding For Communications Systems
- I. Section 27 05 53 - Identification For Communications Systems
- J. Section 27 10 05 - Communications Copper Cabling: Data cables for access control system IP network connections.
- K. Section 28 20 00 - Video Surveillance: For interface with access control system.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2023.
- C. NEMA - National Electrical Manufacturers Association.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- E. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- F. NFPA 262 - Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
- G. NFPA 730 - Guide for Premises Security.

- H. NFPA 731 - Standards for the Installation of Electronic Premises Security
- I. UL 294 - Access Control System Units; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the work with other installers to provide suitable door hardware as required for both access control functionality and code compliance.
 - 2. Coordinate the placement of readers with millwork, furniture, equipment, etc. installed under other sections or by others.
 - 3. Coordinate the work with other installers to provide power for equipment at required locations.
 - 4. Coordinate the work with Manufacturer's Representative Services supplier for access control equipment, installation, testing, adjusting, integration, and system start-up.
 - 5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Preinstallation Meetings:
 - 1. Conduct meeting with facility representative to review reader and equipment locations.
 - 2. Conduct meeting with facility representative and other related equipment manufacturers to discuss access control system interface requirements.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- C. Product Data: Provide manufacturer's standard catalog pages and data sheets for each system component. Include ratings, configurations, standard wiring diagrams, dimensions, finishes, service condition requirements, and installed features.
- D. Design Data: Standby battery/UPS calculations.
- E. Certify that proposed system design and components meet or exceed specified requirements.
- F. Evidence of qualifications for installer.
- G. Evidence of qualifications for maintenance contractor (if different entity from installer).
- H. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
- I. Manufacturer's detailed field testing procedures.
- J. Field quality control test reports.
- K. Maintenance contracts.
- L. Project Record Documents: Record actual locations of system components and installed wiring arrangements and routing.
- M. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

- N. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
- O. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Deliver blank credentials to Owner as directed.

1.6 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. NFPA 101 (Life Safety Code).
 - 3. The requirements of the local authorities having jurisdiction.
 - 4. Applicable TIA/EIA standards.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with access control systems of similar size, type, and complexity and providing contract maintenance service as a regular part of their business; authorized manufacturer's representative.
 - 1. Contract maintenance office located within 100 miles of project site.
- E. Maintenance Contractor Qualifications: Same entity as installer.
- F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.
- B. Store products in manufacturer's unopened packaging, keep dry and protect from damage until ready for installation.

1.8 FIELD CONDITIONS

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

1.9 WARRANTY

- A. See Section 01 78 00 - 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

2.1 SYSTEM DESCRIPTION

- A. The intent of this specification is to lay out the infrastructure requirements for an expansion of the Owner's Access Control System (ACS) and coordinate the installation of the security equipment furnished to the electrical contractor at points indicated on the Drawings.

- B. Provide all structured cabling, terminations, boxes, conduit, penetrations, sleeves, wire-mold, fasteners, and common installation material such that the project has a complete and workable access control system compliant with this Section. Hardware products which do not meet this design as laid out in Sections 27 05 28 - Pathways For Communications Systems and 27 10 05 - Communications Copper Cabling, shall not be acceptable.
- C. Install all equipment furnished by the Manufacturer's Representative Services supplier referred to in this specification as the Integrator. The electrical contractor shall coordinate with the Integrator the transmittal of equipment, verification of the access control schedule, field installation, and commissioning of the communications cabling system that supports the system.
- D. The electrical contractor shall provide all necessary coordination with the Integrator to produce a fully commissioned Access Control System.

2.2 OWNER-FURNISHED PRODUCTS AND SERVICES

- A. ACS equipment for the project shall be purchased by the Owner via New York State Contract.
 - 1. Identified products shall be installed by the Owner or System Integrator.
 - 2. Remaining products identified as furnished by the Owner shall be turned over to the Electrical Contractor for installation.
 - 3. Refer to the Responsibility Matrix later in this Section for product listing.
- B. The Owner has further entered into a separate contract for Manufacturer's Representative Services.
 - 1. The term Manufacturer's Representative Services supplier shall be synonymous with and interchangeable with the terms Integrator or System Integrator.
 - 2. The Manufacturer's Representative Services supplier for the project is:
 - a. Day Automation Systems, Inc. 7931 Rae Boulevard Rochester, NY 14475 phone: 800-836-0969.
 - 3. Refer to Responsibility Matrix later in this Section for description of services provided.
- C. For a complete listing of Owner-Furnished products including Manufacturer, model, and description, contact the Manufacturer's Representative Services supplier.

2.3 PRODUCTS

- A. Provide such equipment as outlined in the responsibility matrix below, including but not limited to:
 - 1. Patch Cables: As specified in Section 27 10 05 - Communications Copper Cabling.
 - 2. Data Cable Surge Suppression: As specified in Section 27 05 26 - Grounding and Bonding For Communications Systems.
 - 3. Patch Panels: As specified in Section 27 10 05 - Communications Copper Cabling.
- B. Install equipment, identified in the responsibility matrix below, as supplied by the Owner, but not installed by the Owner or Integrator.
- C. Provide wiring, conduit, wire terminations, back boxes, wire-mold, fasteners and common installation material required to connect devices furnished as part of, or integral to the Access Control System regardless of the source of the supply.
 - 1. Provide all wiring and terminations for the Access Control System in accordance with the specifications, contract drawings, and detailed engineered drawings provided by factory representative.
- D. Provide all other devices required for proper complete system operation including, but not limited to, electrical switches, transformers, disconnect switches, sensors, safety devices, power supplies, enclosure, and circuit breakers.
- E. **Reference the responsibility matrix below:**
 - EC - Prime Electrical Contractor
 - Owner - Project Owner
 - Integrator - System Integrator

<u>Products</u>	<u>Furnished By</u>	<u>Installed By</u>	<u>Control Wiring By</u>	<u>Programmed By</u>
Access Control Panels	Owner	EC	EC	Integrator
Access Door Control Modules	Owner	EC	EC	Integrator
Input/Output Boards	Owner	EC	EC	N/A
Proximity Card Readers	Owner	EC	EC	Integrator
Door Contacts	Owner	EC	EC	Integrator
Request To Exit Sensors	Owner	EC	EC	Integrator
Relays	Owner	EC	EC	Integrator
ADA Panels	Owner	EC	EC	Integrator

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install access control system in accordance with NECA 1 (general workmanship).
- B. Install products in accordance with manufacturer's instructions.
- C. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 1. Use suitable listed cables in wet locations, including underground raceways.
 2. Use suitable listed cables for vertical riser applications.
 3. Use listed plenum rated cables in spaces used for environmental air.
 4. Install wiring in conduit for the following:
 - a. Where required for rough-in.
 - b. Where required by authorities having jurisdiction.
 - c. Where exposed to damage.
 - d. Where installed outside the building.
 - e. For exposed connections from outlet boxes to devices.
 5. Conduit: Comply with Section 26 05 33.13.
 6. Conceal all cables unless specifically indicated to be exposed.
 7. Use power transfer hinges complying with Section 08 71 00 for concealed connections to door hardware.
 8. Cables in the following areas may be exposed, unless otherwise indicated:
 - a. Equipment closets.
 - b. Within joists in areas with no ceiling.
 9. Route exposed cables parallel or perpendicular to building structural members and surfaces.
 10. Do not exceed manufacturer's recommended maximum cable length between components.
- D. Provide grounding and bonding in accordance with Section 27 05 26.

- E. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- F. Identify system wiring and components in accordance with Section 27 05 53.
- G. Provide wiring in conduit per NEC and Local codes.
- H. Provide wiring and connections to door hardware devices.
- I. Ground and bond security access equipment and circuits in accordance with Section 26 05 26.
- J. Electronic locking devices shall have a separate power supply. Provide and install power supplies as required to support the locks. The unit shall incorporate integral battery charging capabilities and a fused line voltage input for individual locks. All power supplies shall be equipped with optional battery pack for up to 24 hours of backup. As required, the unit shall be equipped with a module to accommodate fire alarm NC contacts when a fire alarm activates.
- K. Provide all interface wiring, relays, connections and programming required to interface electric locking/unlocking of door hardware with powered door openers/actuator buttons.
 - 1. Entry from exterior through door during scheduled lock times: Exterior ADA actuator button/powered opener will be disabled until authorized credentials (card, fob) are presented to Access system reader. Access control system to activate door opener actuator buttons so that when in a locked position, an entry door powered opener will NOT engage against a door with the latch in the locked position. User must first present an authorized credential to the card reader to unlock the door. Authorized credential will unlock door and either initiate opening of door or activate the pushbutton for powered opening activation.
 - a. When entry point has second set of interior Vestibule doors with powered opener, and no actuator button inside the Vestibule, the interior opened door must have programmed time delay to stay open for a sufficient time to allow the persons to pass through.
 - 2. Exit at powered door in scheduled lock times: Upon pushing interior located actuator button(s), the access control system will unlock associated doors and allow the person to pass through door(s) and exit the building. Doors to close and lock after (adjustable) set time period.
- L. At locations with removable mullions and electric strikes, provide quick disconnect plugs in order to facilitate the removal of the mullion without cutting the wires to the electric strike.
- M. All conduit sleeves and holes shall be ground smooth to remove all sharp edges and burrs that could potentially damage cabling. All cabling shall be supported and protected at all holes, penetration points, boxes, conduit, etc. with protective grommets or material that will protect the cabling from any abrasive contact with surfaces that might cause damage.
- N. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.
- O. It is the installer's / contractor's responsibility to test every aspect of the ACS system and document the location and performance of every cable, termination point, riser, control panel, Card Reader, Door contact, rex, Input point, and all associated software functions.
- P. All cable management (troughs) are mounted tight, level and square with all fasteners installed and be free of debris on the inside and outside.
- Q. All cabling outside enclosures are installed free from sharp edges and dressed neatly.
- R. Cables installed using approved method when not in cable management trays.
- S. Cable management not to use adhesive tie wraps, due to loss of secure mounting.
- T. Cables enter and leave junction boxes using proper bushings, fittings, grommets.
- U. All wiring to be neatly dressed. All Bend radii are sufficient, and equate to cable type requirements.

- V. Cable runs are continuous and not spliced. Field splice connections will be documented and only as necessary to end of line device to minimize points of failure/DB loss. Field splice connections will be in secured enclosure.
- W. All terminations at field devices are visually inspected to ensure properly soldered-no dolphins, wire nuts or b-connects.
- X. All field devices mounted using approved installation fasteners and hardware to ensure serviceability (field devices can be removed and remounted)
- Y. All field devices mounted tight, level, square and sealed as needed for weatherproof applications.
- Z. All terminations at field devices are inspected to ensure there are no bare wire conductors and all is insulated and shrink wrapped. All spare un-terminated conductors are properly safe-ended with shrink wrap.
- AA. Supervision EOL resistors are located at the field device to be supervised.
- BB. Cable installation shall not impact any existing cabling infrastructure.

3.3 SYSTEM PROGRAMMING

- A. The Contractor and the ACS Vendor are jointly responsible for Initial Programming and report formatting of the ACS as specified herein and as directed by the owner/owner representative. The owner will convey their programmable operational requirements for all system functions in lay terms, and Initial System programming will be completed to satisfy the owner's requirements.
- B. The Contractor and the ACS Vendor will be required to meet with the owner's representatives a Min. 3 times to discuss, recommend and document the owner's needs for programming and sequences of operation.
- C. Programming Functions to be provided shall include but not be limited to:
 - 1. Schedules, groups and sequence of operation(s) for:
 - a. Access Groups
 - b. Access Levels
 - c. Actions
 - d. Action Groups
 - e. Alarm Inputs
 - f. Alarm Mask Groups
 - g. Alarm Outputs
 - h. Areas
 - i. Badge Types
 - j. Badge creation
 - k. Card Formats
 - l. Cardholders
 - m. Card Readers
 - n. Global I/O Function Lists
 - o. Global I/O Links
 - p. Holidays
 - q. Maps
 - r. Monitor Zones
 - s. Receiver Accounts
 - t. System Operators
 - u. User Permission Groups
 - v. Time Zones
 - w. Visitor management
 - 2. Initial Graphic Map creation with icons and programming setup
 - 3. Set-up and pathing of all alarm notifications
 - 4. Report generation and formats for printing and notifications.
 - 5. Door Monitoring Status: Alarm Conditions; Graphic Annunciation

ACCESS CONTROL

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Provide services of a manufacturer's authorized representative to observe installation and assist in inspection and testing. Include manufacturer's detailed testing procedures and field reports with submittals.
- C. Prepare and start system in accordance with manufacturer's instructions.
- D. Program system parameters according to requirements of Owner.
- E. Test for proper interface with other systems.
- F. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- G. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.5 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.6 DEMONSTRATION AND MANUALS

- A. Manuals: Final copies of the manuals shall be delivered after completing the installation test with signed (owner/owner representative) proof of receipt. Each manual's contents shall be identified on the cover. The manual shall include names, addresses, and telephone numbers of the contractor responsible for the installation and maintenance of the system and the factory representatives for each item of equipment for each system. The manuals shall have a table of contents and labeled sections. The final copies delivered after completion of the installation test shall include all modifications made during installation, checkout, and acceptance testing. The manuals shall consist of the following:
- B. Functional Design Manual: The functional design manual shall identify the operational requirements for the system and explain the theory of operation, design philosophy, and specific functions. A description of hardware and software functions, interfaces, and requirements shall be included.
- C. Hardware Manual: The manual shall describe all equipment furnished including:
 - 1. General description and specifications
 - 2. Installation and check out procedures
 - 3. Equipment layout and electrical schematics to the component level
 - 4. System layout drawings and schematics
 - 5. Alignment and calibration procedures
 - 6. Manufacturers repair parts list indicating sources of supply
- D. Software Manual: The software manual shall describe the functions of all software and shall include all other information necessary to enable proper loading, testing, and operation. The manual shall include:
 - 1. Definition of terms and functions
 - 2. System use and application software
 - 3. Initialization, start up, and shut down
 - 4. Reports generation
 - 5. Details on forms customization and field parameters
 - 6. Operators Manual: The operators manual shall fully explain all procedures and instructions for the operation of the system including:
 - 7. Computers and peripherals
 - 8. System start up and shut down procedures
 - 9. Use of system, command, and applications software
 - 10. Recovery and restart procedures

11. Graphic alarm presentation
12. Use of report generator and generation of reports
13. Data entry
14. Operator commands
15. Alarm messages and reprinting formats
16. System permissions functions and requirements

- E. Maintenance Manual: The maintenance manual shall include descriptions of maintenance for all equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
- F. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the ACS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the ACS. Copies of the final as-built drawings shall be provided to the end user in DXF format.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Demonstration: Demonstrate proper operation of system to Owner, and correct deficiencies or make adjustments as directed.
- C. Training: Train Owner's personnel on operation, adjustment, and maintenance of system.
1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Provide minimum of four hours of training.
 3. Instructor: Manufacturer's authorized representative.
 4. Location: At project site.

3.8 PROTECTION

- A. Protect installed system components from subsequent construction operations.

3.9 MAINTENANCE

- A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- B. Provide to Owner, a proposal as an alternate to the base bid, a separate maintenance contract for the service and maintenance of access control system for two years from date of Substantial Completion; Include a complete description of preventive maintenance, systematic examination, adjustment, cleaning, inspection, and testing, with a detailed schedule.

END OF SECTION

SECTION 28 20 00
VIDEO SURVEILLANCE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Video surveillance system requirements.
- B. Video recording and viewing equipment.
- C. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping.
- B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
- C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
- E. Section 26 05 33.13 - Conduit for Electrical Systems.
- F. Section 26 05 33.16 - Boxes for Electrical Systems
- G. Section 27 05 26 - Grounding and Bonding For Communications Systems.
- H. Section 27 05 28 - Pathways For Communications Systems
- I. Section 27 05 53 - Identification For Communications Systems.
- J. Section 27 10 05 - Communications Copper Cabling: Data cables for IP video surveillance system network connections.
- K. Section 27 15 55 - Communications Cable Testing.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate the placement of cameras with structural members, ductwork, piping, equipment, luminaires, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
 - 2. Coordinate the work with Manufacturer's Representative Services supplier for cameras and equipment, installation, testing, adjusting, integration, and system start-up.
 - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
- B. Preinstallation Meetings:
 - 1. Conduct meeting with facility representative to review camera and equipment locations and camera field of view objectives.
 - 2. Conduct meeting with facility representative and other related equipment manufacturers to discuss video surveillance system interface requirements.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Shop Drawings: Include plan views indicating locations of system components and proposed size, type, and routing of conduits and/or cables. Include elevations and details of proposed equipment arrangements. Include system interconnection schematic diagrams. Include requirements for interface with other systems.
- C. Evidence of qualifications for installer.
- D. Field quality control test reports.
- E. Project Record Documents: Record actual locations of cameras and routing of cables.
- F. Operation and Maintenance Data: Include detailed information on system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.
 - 1. Include contact information for entity that will be providing contract maintenance and trouble call-back service.

1.5 QUALITY ASSURANCE

- A. Comply with the following:
 - 1. NFPA 70.
 - 2. Applicable TIA/EIA standards.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of project.
- D. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience with video surveillance systems of similar size, type, and complexity.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions and NECA 303.
- B. Store products in manufacturer's packaging, keep dry and protect from damage until ready for installation.

1.7 FIELD CONDITIONS

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

1.8 WARRANTY

- A. See Section 01 78 00 - 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

2.1 SYSTEM DESCRIPTION

- A. The intent of this specification is to lay out the infrastructure requirements for an expansion of the Owner's Digital Video Management System (DVMS) and coordinate the installation of the security equipment furnished to the electrical contractor at points indicated on the Drawings.
- B. Provide all structured cabling, terminations, boxes, conduit, penetrations, sleeves, wire-mold, fasteners, and common installation material such that the project has a complete and workable video surveillance system compliant with this Section. Hardware products which do not meet this design as laid out in Sections 27 05 28 - Pathways For Communications Systems and 27 10 05 - Communications Copper Cabling, shall not be acceptable.
- C. Install all equipment furnished by the Manufacturer's Representative Services supplier referred to in this specification as the Integrator. The electrical contractor shall coordinate with the Integrator the transmittal of equipment, verification of the camera schedule, field installation, final aiming and commissioning of the communications cabling system that supports the system.
- D. The electrical contractor shall provide all necessary coordination with the Integrator to produce a fully commissioned DVMS & IP Security Camera system.

2.2 OWNER-FURNISHED PRODUCTS AND SERVICES

- A. DVMS equipment for the project shall be purchased by the Owner via New York State Contract.
 - 1. Identified products shall be installed by the Owner or System Integrator.
 - 2. Remaining products identified as furnished by the Owner shall be turned over to the Electrical Contractor for installation.
 - 3. Refer to the Responsibility Matrix later in this Section for product listing.
- B. The Owner has further entered into a separate contract for Manufacturer's Representative Services.
 - 1. The term Manufacturer's Representative Services supplier shall be synonymous with and interchangeable with the terms Integrator or System Integrator.
 - 2. The Manufacturer's Representative Services supplier for the project is:
 - a. Day Automation Systems, Inc. 7931 Rae Boulevard Rochester, NY 14475 phone: 800-836-0969.
 - 3. Refer to Responsibility Matrix later in this Section for description of services provided.
- C. For a complete listing of Owner-Furnished products including Manufacturer, model, and description, contact the Manufacturer's Representative Services supplier.

2.3 PRODUCTS

- A. Provide such equipment as outlined in the responsibility matrix below, including but not limited to:
 - 1. Patch Cables: As specified in Section 27 10 05 - Communications Copper Cabling.
 - 2. Data Cable Surge Suppression: As specified in Section 27 05 26 - Grounding and Bonding For Communications Systems.
 - 3. Patch Panels: As specified in Section 27 10 05 - Communications Copper Cabling.
- B. Install equipment, identified in the responsibility matrix below, as supplied by the Owner, but not installed by the Owner or Integrator.
- C. Provide wiring, conduit, wire terminations, back boxes, wire-mold, fasteners and common installation material required to connect devices furnished as part of, or integral to the DVMS system regardless of the source of the supply.
 - 1. Provide all wiring and terminations for the DVMS system in accordance with the specifications, contract drawings, and detailed engineered drawings provided by factory representative.
- D. Provide all other devices required for proper complete system operation including, but not limited to, electrical switches, transformers, disconnect switches, sensors, safety devices, power supplies, enclosure, and circuit breakers.

E. Reference the responsibility matrix below:

EC - Prime Electrical Contractor

Owner - Project Owner

Integrator - System Integrator

PRODUCTS	FURNISHED BY	INSTALLED BY	SIGNAL WIRING BY	PROGRAMMED BY
NETWORK VIDEO RECORDER	OWNER	OWNER / INTEGRATOR	EC	INTEGRATOR
CAMERAS & MOUNTS	OWNER	EC	EC	INTEGRATOR
CAMERA SOFTWARE LICENSE	OWNER	INTEGRATOR	N/A	INTEGRATOR
PATCH CABLES	EC	EC	EC	N/A
DATA CABLE SURGE SUPPRESSION	EC	EC	EC	N/A
PATCH PANELS	EC	EC	EC	N/A
UPS	OWNER	OWNER / INTEGRATOR	EC	INTEGRATOR
NETWORK SWITCHES	OWNER	OWNER / INTEGRATOR	EC	INTEGRATOR
ENCODERS	OWNER	OWNER / INTEGRATOR	EC	INTEGRATOR

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to system.
- E. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION

- A. Install video surveillance system in accordance with NECA 1 (general workmanship) and NECA 303.
- B. Comply with the provisions of NFPA 70.
- C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.
- D. Provide required support and attachment in accordance with Section 26 05 29.
- E. Wiring Method: Unless otherwise indicated, use cables (not in conduit).
 - 1. Use listed plenum rated cables in all spaces.
 - 2. Conduit: Comply with Section 26 05 33.13.

3. Conceal all cables unless specifically indicated to be exposed.
 4. Cables in the following areas may be exposed, unless otherwise indicated:
 - a. Equipment closets.
 5. Route exposed cables parallel or perpendicular to building structural members and surfaces.
 6. Include service loop cable lengths to allow relocation of cameras within 10 ft of installed location.
- F. Provide grounding and bonding in accordance with Section 27 05 26.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
- H. Identify system wiring and components in accordance with Section 27 05 53.
- I. Label all cameras per Owner requirements and to match as in software naming convention.
- J. For IP Cameras: Test all cabling per Section 27 15 55.
- K. The Contractor shall carefully follow instructions in documentation provided by the manufacturers to insure all steps have been taken to provide a reliable system.
- L. Coordinate with the Manufacturer's Representative Services supplier to ensure the following:
 1. All cameras are verified for start up and software programming.
 2. All equipment has been tested and configured in accordance with instructions provided by the manufacturer prior to installation.
- M. Coordinate all final locations with owner. Get sign off from owner on final view of camera.

3.3 DVMS - GROUNDING

- A. The Grounding wires connected from the Surge devices and earth ground to be grounded according to NEC and NFPA related codes. Grounding to common electrical building ground to be verified prior to install via measurement of resistance to ground in grounding system connection points. Grounding shall eliminate potential equipment damage from possible ground loops created by multiple ground rods. It shall allow the electrical potential of the entire facility to rise and fall in a uniform manner, reducing the possibility of excessive current flow on the grounding system.
- B. Whenever possible, the conductor length to earth ground should be less than the conductor length from the surge suppression device to the protected equipment.
- C. When connecting a parallel surge suppression device to a building ground system, the leads from the surge suppression device should be as short and straight as possible.
- D. The ground system should have a maximum resistance of 25 ohms. 5 ohms, or less, is the preferred level for optimum performance of the surge suppression device.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Interface installation of video surveillance with security access and intrusion detection systems.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Coordinate with the Manufacturer's Representative Services supplier for the following:
 1. Perform inspection and testing.
 2. Prepare and start system in accordance with manufacturer's instructions.
 3. Adjust cameras to provide desired field of view and produce suitable images under all service lighting conditions.
 4. Program system parameters according to requirements of Owner.
 5. Test for proper interface with other systems.

- C. Each shall correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.
- D. Submit detailed reports indicating inspection and testing results and corrective actions taken.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. Coordinate with the Manufacturer's Representative Services supplier for the following:
 - 1. Demonstration: Demonstrate proper operation of system to Owner.
 - a. Provide personnel to correct deficiencies or make adjustments as directed.
- C. The Contractor and Manufacturer's Representative Services supplier shall each provide a Hardware Manual as it relates to the products supplied under their scope of work.
 - 1. The manual shall describe all equipment furnished including:
 - a. General description and specifications.
 - b. Installation and check out procedures.
 - c. Equipment layout and electrical schematics to the component level.
 - d. System layout drawings and schematics.
 - e. Alignment and calibration procedures.
 - f. Manufacturers' repair parts list indicating sources of supply.
- D. As-Built Drawings: During system installation, the Contractor shall maintain a separate hard copy set of drawings, elementary diagrams, and wiring diagrams of the DVMS to be used for record drawings. This set shall be accurately kept up to date by the Contractor with all changes and additions to the DVMS. Copies of the final as-built drawings shall be provided to the end user in PDF format.

3.8 PROTECTION

- A. Protect installed system components from subsequent construction operations.

END OF SECTION

SECTION 28 46 00
FIRE DETECTION AND ALARM

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fire alarm system design and installation, including all components, wiring, and conduit.

1.2 RELATED REQUIREMENTS

- A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.

1.3 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - Americans with Disabilities Act (ADA) Standards for Accessible Design; 2010.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 72 - National Fire Alarm and Signaling Code; Most Recent Edition Cited by Referring Code or Reference Standard.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Evidence of designer qualifications.
- C. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
 - 1. Copy (if any) of list of data required by authority having jurisdiction.
 - 2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
 - 3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
 - 4. System zone boundaries and interfaces to fire safety systems.
 - 5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
 - 6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
 - 7. List of all devices on each signaling line circuit, with spare capacity indicated.
 - 8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
 - 9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
 - 10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
 - 11. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.

- 12. Certification by Contractor that the system design complies with Contract Documents.
- D. Evidence of installer qualifications.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
 - 1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
 - 2. Installer Personnel: At least 2 years of experience installing fire alarm systems.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Fire Alarm Control Units and Accessories:
 - 1. Siemens Building Technologies, Inc; Kidde: www.usa.siemens.com/#sle.
 - 2. Provide control units made by the same manufacturer.
- B. Substitutions: See Section 01 60 00 - Product Requirements.
 - 1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.

2.2 FIRE ALARM SYSTEM

- A. Fire Alarm System: Provide a new automatic fire detection and alarm system:
 - 1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
 - 2. Protected Premises: outbuildings at Bath Central School District.
 - 3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
 - a. ADA Standards.
 - b. The requirements of the local authority having jurisdiction, which is _____.
 - c. Applicable local codes.
 - d. Contract Documents (drawings and specifications).
 - e. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
 - 4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
- B. Circuits:
 - 1. Initiating Device Circuits (IDC): Class B, Style A.
 - 2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
 - 3. Notification Appliance Circuits (NAC): Class B, Style W.
- C. Power Sources:
 - 1. Primary: Dedicated branch circuits of the facility power distribution system.
 - 2. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.3 FIRE SAFETY SYSTEMS INTERFACES

- A. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:

2.4 COMPONENTS

- A. General:
 - 1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
 - 2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
- B. Fire Alarm Control Units: Conventional type; listed, classified, and labeled as suitable for the purpose intended.
- C. 120V AC Integrated - Basis of Design: Kidde 120V AC Integrated 2-in-1 LED Strobe and 10-year Talking Smoke Alarm.
 - 1. Interconnection of 24 devices
 - 2. Voice Integration:
 - a. Provide audio notification to occupants.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.
- B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.
- C. Obtain Owner's approval of locations of devices, before installation.
- D. Install instruction cards and labels.

3.2 INSPECTION AND TESTING FOR COMPLETION

- A. Notify Owner 7 days prior to beginning completion inspections and tests.
- B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.
- C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.
- D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.
- E. Provide all tools, software, and supplies required to accomplish inspection and testing.
- F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.
- G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

3.3 CLOSEOUT

- A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
 - 1. Be prepared to conduct any of the required tests.

2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
3. Have authorized technical representative of control unit manufacturer present during demonstration.
4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
5. Repeat demonstration until successful.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removal or protection of designated trees, shrubs, and other plant life.
- B. Repair and restoration.
- C. Removal of existing surface debris.
- D. Removing designated paving, curbs.
- E. Demolition and removal of above grade improvements.
- F. Disconnecting, capping or sealing, and removal/abandoned utilities.
- G. Excavating of subsoil and topsoil.

1.2 RELATED REQUIREMENTS

- A. Section 01 57 13 - Temporary Erosion and Sediment Control.
- B. Section 31 23 23 - Fill: Material for filling holes, pits, and excavations generated as result of removal operations.

1.3 REFERENCE STANDARDS

- A. 29 CFR 1910.266 - Logging Operations; Current Edition.
- B. ANSI Z133 - American National Standard for Arboricultural Operations - Safety Requirements; 2017.

1.4 DEFINITIONS

- A. Remove: Remove and legally dispose of items except those indicated to be reinstalled, salvaged, or to remain the Owner's property.
- B. Remove and Salvage: Items indicated to be removed and salvaged remain the Owner's property. Remove, clean, and pack or crate items to protect against damage. Identify contents of containers and deliver to Owner's designated storage area.
- C. Remove and Reinstall: Remove items indicated; clean, service, and otherwise prepare them for reuse; store and protect against damage. Reinstall items in locations indicated.

1.5 MATERIALS OWNERSHIP

- A. Except for items or materials indicated to be reused, salvaged, or otherwise indicated to remain the Owner's property, demolished materials shall become the Contractor's property and shall be removed from the site with further disposition at the Contractor's option.
- B. Historical items, relics, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other items of interest or value to the Owner, which may be encountered during demolition, remain the Owner's property. Carefully remove and salvage each item or object in a manner to prevent damage and deliver promptly to the Owner.

- C. The Contractor is responsible for cutting all marked trees to log length and stock piling the logs for the property owner on site at property owners designated location.

1.6 PROJECT CONDITIONS

- A. Traffic: Conduct site clearing operations to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities. Do not close or obstruct streets, walks or other occupied or used facilities without permission from authorities having jurisdiction.
- B. Protection of Existing Improvements: Provide protections necessary to prevent damage to existing improvements indicated to remain in place.
 - 1. Protect improvements on adjoining properties and on Owner's property.
 - 2. Restore damaged improvements to their original condition, as acceptable to property owners.
- C. Protection of Existing Trees and Vegetation: Protect existing trees and other vegetation indicated to remain in place, against unnecessary cutting, breaking or skinning of roots, skinning or bruising of bark, smothering of trees by stockpiling construction materials or excavated materials within drip line, excess foot or vehicular traffic, or parking of vehicles within drip line. Provide temporary guards to protect trees and vegetation to remain at drip line.
- D. Salvageable Improvements: Carefully remove items indicated to be salvaged, and store on Owner's premises where indicated or directed.
- E. If indicated, Buildings to be demolished or relocated will be vacated and their use discontinued before start of Work.
- F. If indicated, Owner assumes no responsibility for actual condition of buildings to be demolished or relocated.
- G. Owner will maintain conditions existing at time of inspection for bidding purpose as far as practical.
- H. Storage or sale of removed items or materials on-site will not be permitted.
- I. Explosives: Use of explosives will not be permitted.

1.7 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Site Plan:
 - 1. Indicate vegetation removal limits.
 - 2. Indicate areas for temporary construction and field offices.
- C. Schedule of demolition activities indicating the following:
 - 1. The Owner reserves the right to claim any material scheduled for demolition. No demolition materials are to be removed from job site without approval of the Construction Manager.
 - 2. Detailed sequence of demolition and removal work, with starting and ending dates for each activity.
 - 3. Dates for shutoff, capping, and continuation of utility services.
- D. Inventory of items to be removed and salvaged.
- E. Inventory of items to be removed by Owner.
- F. Photographs and videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by demolition operations.
- G. Record drawings at Project closeout according to Division 1 Section "Contract Closeout."
 - 1. Identify and accurately locate capped utilities and other subsurface structural, electrical, or mechanical conditions.

1.8 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Engage an experienced firm that has successfully completed demolition Work similar to that indicated for this Project.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before starting demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- C. Clearing Firm Qualifications: Company specializing in performing work of type specified and with at least five years of documented experience.

1.9 SCHEDULING

- A. Arrange demolition schedule so as not to interfere with Owner's on-site operations.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Sedimentation Barrier: See Section 01 57 13 - Temporary Erosion and Sediment Control.
- B. Fill material: As specified in Section 31 23 23 - Fill and Backfill.
- C. Herbicides: Not allowed.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify existing plant life designated to remain is tagged or identified.
- C. Identify salvage area for placing removed materials.
- D. Verify that utilities have been disconnected and capped.
- E. Survey existing conditions and correlate with requirements indicated to determine extent of demolition required.
- F. Inventory and record the condition of items to be removed and reinstalled and items to be removed and salvaged.
- G. Survey the condition of the building to determine whether removing any element might result in a structural deficiency or unplanned collapse of any portion of the structure or adjacent structures during demolition or relocation.
- H. Perform surveys as the Work progresses to detect hazards resulting from demolition activities.

3.2 INITIAL PREPARATION

- A. Call Local Utility One Call Center @ 811 in the State of New York, not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.

3.3 PROTECTION

- A. Locate, identify, and protect utilities indicated to remain, from damage.
- B. Protect trees, plant growth, and features designated to remain, as final landscaping as specified in Section 01 50 00 - Temporary Facilities and Controls.
- C. Protect bench marks, survey control points, and existing structures from damage or displacement.

3.4 UTILITY SERVICES

- A. Maintain existing utilities indicated to remain in service and protect them against damage during demolition operations.
- B. Do not interrupt existing utilities serving occupied or operating facilities, except when authorized in writing by Owner and authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, as acceptable to Owner and to governing authorities.
- C. Provide not less than 72 hours' notice to Owner if shutdown of service is required during changeover.
- D. Utility Requirements: Locate, identify, disconnect, and seal or cap off indicated utility services serving structures to be demolished.
- E. Owner will arrange to shut off indicated utilities when requested by Contractor.
- F. Utility Requirements: Refer applicable specification sections for shutting off, disconnecting, removing, and sealing or capping utility services. Do not start demolition work until utility disconnecting and sealing have been completed and verified in writing.

3.5 PREPARATION

- A. Drain, purge, or otherwise remove, collect, and dispose of chemicals, gases, explosives, acids, flammables, or other dangerous materials before proceeding with demolition operations.
- B. Conduct demolition operations and remove debris to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
- C. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.
- D. Conduct demolition operations to prevent injury to people and damage to adjacent buildings and facilities to remain. Ensure safe passage of people around demolition area.
- E. Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction.
- F. Protect existing site improvements, appurtenances, and landscaping to remain.
- G. Provide and maintain interior and exterior shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of buildings to be demolished or related and adjacent buildings to remain.
- H. Strengthen or add new supports when required.

3.6 POLLUTION CONTROLS

- A. Use water mist, temporary enclosures, and other suitable methods to limit the spread of dust and dirt. Comply with governing environmental protection regulations.
- B. Do not create hazardous or objectionable conditions, such as ice, flooding, and pollution, when using water.

- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level.
- E. Clean adjacent buildings and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to condition existing before start of demolition.

3.7 CLEARING

- A. General: Remove trees, shrubs, grass and other vegetation, improvements, or obstructions as required to permit installation of new construction. Remove similar items elsewhere on site or premises as specifically indicated. "Removal" includes digging out and off-site disposing of stumps, roots, and branches.
- B. Cut minor roots and branches of trees indicated to remain in a clean and careful manner, where such roots and branches obstruct installation of new construction.
- C. Topsoil: Topsoil is defined as friable clay loam surface soil found in a depth of not less than 4 inches. Satisfactory topsoil is reasonably free of subsoil, clay lumps, stones, and other objects over ½" inch in diameter, and without weeds, roots, and other objectionable material.
- D. Do not remove wet topsoil.
- E. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material.
 - 1. Do not remove topsoil from site.
- F. Remove heavy growths of grass from areas before stripping.
- G. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.
- H. Stockpile topsoil in storage piles. Construct storage piles on site to a depth not exceeding 8 feet and protect from erosion. Cover storage piles, if required, to prevent wind erosion.
- I. Fill depressions caused by clearing and grubbing operations with satisfactory soil material, unless further excavation or earthwork is indicated.
- J. Place fill material in horizontal layers not exceeding 6 inches loose depth, and thoroughly compact to a density equal to adjacent original ground.
- K. Removal of Improvements: Remove existing above-grade and below-grade improvements as indicated and as necessary to facilitate new construction.
- L. Clear areas required for access to site and execution of Work to minimum depth of 12 inches.
- M. Clear undergrowth and deadwood, without disturbing subsoils.
- N. Removed timber and stumps that are unwanted by the Owner or landowner shall be properly disposed of.

3.8 REMOVAL

- A. Remove debris, rock, and extracted plant life from site.
- B. Remove paving, walks and curbs as indicated on Drawings. Neatly saw cut edges at right angle to surface and at right angles to adjoining structures. Saw cut concrete pavement as indicated at locations shown on drawings nearest to existing joint.
- C. Remove abandoned utilities. Indicated removal termination point for underground utilities on Record Documents.

- D. Continuously clean-up and remove waste materials from site. Do not allow materials to accumulate on site.
- E. Do not burn or bury materials on site. Leave site in clean condition.

3.9 DEMOLITION

- A. Building Demolition: Demolish buildings completely and remove all building debris from the site. Use methods required to complete Work within limitations of governing regulations and as follows:
- B. Locate demolition equipment throughout the building and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
- C. Dispose of demolished items and materials promptly. On-site storage or sale of removed items is prohibited.
- D. Demolish concrete and masonry in small sections.
- E. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
- F. Break up and remove concrete slab on grade, unless or shown to remain on drawings.
- G. Below-Grade Construction: Demolish foundation walls and other below-grade construction, as follows:
- H. Unless directed otherwise completely remove below-grade construction, including foundation walls and footings, and concrete slabs.
- I. Break up and remove below-grade concrete slabs, unless indicated to remain.
- J. Filling Below-Grade Areas: Completely fill below-grade areas and voids resulting from demolition of buildings and pavements with soil materials as required.
- K. Damages: Promptly repair damages to adjacent facilities caused by demolition operations.

3.10 PREPARATION

- A. Coordinate work with utility companies; notify before starting work and comply with local requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Protect existing structures and other elements that are to remain.
- E. Install sedimentation barrier according to Section 01 57 13 - Temporary Erosion and Sediment Control.

3.11 CLEARING AND GRUBBING

- A. Clearing: Cut trees, stumps, shrubs, downed timber, and other vegetation for removal within identified area as indicated on drawings according to 29 CFR 1910.266. Follow recommendations of ANSI Z133 and best local practices for species involved.
- B. Do not remove or damage vegetation beyond limits indicated on drawings.
- C. Grubbing: Remove stumps, roots, buried timber, and other vegetation minimum depth 12 inches (30 cm) from ground. Remove rocks minimum depth 6 inches (15 cm) from ground.

3.12 REMOVED VEGETATION PROCESSING

- A. Do not burn, bury, landfill, or leave on-site, except as indicated on drawings.
- B. Trees: Sell if marketable.
- C. Chip, grind, crush, or shred vegetation for mulching, composting, or other purposes; give preference to on-site uses.

3.13 REPAIR AND RESTORATION

- A. Remaining Existing Facilities, Utilities, and Site Features: If damaged due to this work, repair or replace to original condition.

3.14 DEBRIS REMOVAL

- A. Remove debris, junk, and trash from site.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and windblown debris from public and private lands.

3.15 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Remove unused stockpiled subsoil. Grade stockpile area to prevent standing water.
- C. Leave site clean and ready to receive work.

END OF SECTION

SECTION 31 22 00
GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Removal of subsoil.
- B. Rough grading cutting, filling, rough contouring, compacting, and finished grading the site for site structures, building pads, and trenches.
- C. Fine grading.

1.2 RELATED REQUIREMENTS

- A. Section 31 10 00 - Site Clearing.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill.
- D. Section 32 91 19 - Landscape Grading.

1.3 SUBMITTALS

- A. Materials Source: Submit name of imported materials source.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with Department of Transportation Standards in the State of New York.
- B. Maintain one copy of all construction documents on site.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Fill Materials: See Section 31 23 23.

PART 3 EXECUTION

3.1 EXAMINATION

- A. See Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify survey bench mark and intended elevations for grading areas are as indicated.
- C. Verify the absence of standing or ponding water.

3.2 PREPARATION

- A. Call Local Utility One Call Center @ 811 in the State of New York, not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- B. Identify required lines, levels, contours, and datum.
- C. Stake and flag locations of known utilities.
- D. Locate, identify, and protect above- and below-grade utilities to remain.
- E. Notify utility company to remove and relocate utilities.
- F. Provide temporary means and methods to remove standing or ponding water from areas prior to grading.
- G. Protect site features to remain, including but not limited to bench marks, survey control points, and fences.

3.3 ROUGH GRADING

- A. Excavate and fill subgrade material to elevations indicated on plans.
- B. Horizontally bench existing slopes greater than 1:4.
- C. Remove and replace unsuitable materials as specified fill.

3.4 FINE GRADING

- A. Scrape and spread subgrade material uniformly smooth and without disruptions as indicated on drawings.
- B. Slopes: Transition smoothly to adjacent areas.
- C. See Section 31 23 23 for final compaction.

3.5 REPAIR AND RESTORATION

- A. Existing Facilities, Utilities, and Site Features to Remain: If damaged due to this work, repair or replace to original condition.
- B. Trees to Remain: If damaged due to this work, trim broken branches and repair bark wounds; if root damage has occurred, obtain instructions from Architect as to remedy.
- C. Other Existing Vegetation to Remain: If damaged due to this work, replace with vegetation of equivalent species and size.

3.6 FIELD QUALITY CONTROL

- A. See Section 31 23 23 for compaction density testing.
- B. Perform laboratory material tests in accordance with Department of Transportation Standards in the State of New York.
- C. Perform in place compaction tests in accordance with Department of Transportation Standards in the State of New York.
 - 1. Density Tests.
 - 2. Moisture Tests.
- D. When tests indicate work does not meet specified requirements, remove work, replace and retest.

3.7 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Leave site clean and raked, ready to receive work.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and protection.
- B. Dewatering.
- C. Excavation.
- D. Excavation repairs.
- E. Soil densification

1.2 RELATED REQUIREMENTS

- A. Section 31 10 00 - Site Clearing.
- B. Section 31 22 00 - Grading.
- C. Section 31 23 16.13 - Trenching.
- D. Section 31 23 23 - Fill.

1.3 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Delegated Design Documents: Support and protection plan drawings and calculations sealed by designer.
- C. Field Quality Control Submittals: Document visual inspection of loadbearing excavated surfaces.
- D. Designer's qualification statement.
- E. Shop Drawings: Indicated soil densification grid for each size and configuration footing requiring soils densification.
- F. Shoring installer's qualification statement.
- G. Project Record Documents: Record drawings at project closeout; see Section 01 70 00 - Execution and Closeout Requirements. On drawings, show locations of installed support materials left in place, including referenced locations and depths.

1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Perform design under direct supervision of professional engineer experienced in design of this type of work and licensed in the State of New York.
- B. Perform work in accordance with Department of Transportation Standards in the State of New York.

- C. Shoring Installer Qualifications: Company specializing in performing shoring and bracing work of this section with minimum 3 years of documented experience.
- D. Fill Material Tests: A sieve analysis, loss on ignition, and magnesium sulfate soundness test shall be taken for each type of material from each source of material. Tests will be in accordance with appropriate ASTM methods. Tests shall be taken by an approved independent laboratory and results submitted directly to the Architect before such material is used for fill. Material which fails to meet the specified requirements shall be removed from the site. Payment for tests shall be as described in General Requirements.

1.6 FIELD CONDITIONS

- A. Ambient Conditions: Do not perform excavation during periods of heavy rain as directed by Architect.
- B. Utility Location: Notify Call Before You Dig (811) before excavation to request approximate underground utility marking.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify survey bench mark elevations are as indicated on drawings.
- B. Survey existing adjacent structures and exterior improvements to establish exact elevations at fixed points for bench marking.
- C. Assess adjacent structures and exterior improvements to establish existing conditions. Notify Architect of existing cracks, sags, or other damages prior to starting work.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Protect survey bench marks, control points, and monuments from excavating equipment and vehicular traffic.
- C. Locate and identify known utilities to remain and protect from damage.
- D. Call Local Utility One Call Center @ 811 in the State of New York, not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.
- E. Notify utility company to remove and relocate utilities.

3.3 SUPPORT AND PROTECTION

- A. Excavation Safety: Comply with OSHA's Excavation Standard, 29 CFR 1926, Subpart P.
- B. Permanently leave in place excavation support and protection systems used as formwork or within 10 feet of existing foundations unless otherwise noted on drawings.
 - 1. Remove top 4 feet below grade.
- C. Remove support and protection systems not required to remain in place subject to approval of Architect.

1. Prevent harmful disturbance to underlying soils and damage to buildings, structures, pavements, facilities, and utilities.

3.4 DEWATERING

- A. Prevent surface water and groundwater from entering excavations and surrounding areas.
- B. Dispose of water without causing surface erosion, sediment buildup, or endangering public health or property.

3.5 EXCAVATION

- A. Grade top perimeter of excavation to prevent surface water collection.
- B. General Excavation:
 1. Excavate to indicated contours, elevations, and grades.
- C. Excavation to accommodate construction operations, site structures, underground utilities and paving.
 1. Excavate to specified elevations.
 2. Over-excavate to safely install, adjust, and remove forms, bracing, or supports necessary for installation of work.
 3. Hand trim excavations. Remove loose matter.
- D. See Section 31 23 16.13 for trenching.
- E. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- F. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard measured by volume.
- G. Compact disturbed load bearing soil in direct contact with foundations to original bearing capacity; perform compaction in accordance with Section 31 23 23 and Section 31 23 16.13.
- H. Repair or replace any items indicated to remain damaged by excavation.

3.6 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Provide access for visual inspection of loadbearing excavated surfaces by Architect before proceeding with work.
- C. Resurvey existing adjacent structure and exterior improvement bench marks. Notify Architect of changes in elevations, positions, or slopes.
- D. Notify Architect of additional cracks, sags, or other damages to adjacent structures or exterior improvements occurring during work.

3.7 CLEANING

- A. Stockpile excavated material for re-use in area designated on-site; see Section 31 22 00.
- B. Remove excavated material unsuitable for re-use from site.
- C. Remove excess excavated material from site.

3.8 PROTECTION

- A. Divert surface water away from excavations.
- B. Keep excavations free of standing water.

- C. Maintain stability of banks and loose soils; prevent from falling into excavations.
- D. Maintain excavations in satisfactory, undisturbed condition.
- E. Protect bottom of excavations from freezing.
- F. Protect structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earth operations.

END OF SECTION

SECTION 31 23 16.13
TRENCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Trench excavation.
- B. Backfill and compaction.
- C. Compacted fill from top of utility bedding to subgrade elevations.
- D. Backfilling and compaction.

1.2 RELATED REQUIREMENTS

- A. Section 31 10 00 - Site Clearing.
- B. Section 31 22 00 - Grading.
- C. Section 31 23 16 - Excavation.
- D. Section 31 23 23 - Fill.
- E. Section 32 91 19 - Landscape Grading.

1.3 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop; 2022, with Errata .
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- C. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2015, with Editorial Revision (2016).
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2015.
- F. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.
- G. NRMCA CLSM - Guide Specification for Controlled Low Strength Materials; Current Edition.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Samples: 10 lb sample of each type of fill; submit in air-tight containers to testing laboratory.

- C. Source Quality Control Submittals: Submit name of imported materials source.
 - 1. Results of gradation tests on proposed and actual materials used.
- D. Field Quality Control Submittals:
 - 1. Results of compaction density tests.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Testing agency's qualification statement.
- H. Compaction Density Test Reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Deliver fill to project site in advance of need.
- C. When fill materials need on-site storage, locate stockpiles where indicated on drawings.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion and deterioration of materials.

1.7 QUALITY ASSURANCE

- A. Perform work in accordance with Department of Transportation Standards in the State of New York.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 COORDINATION

- A. See Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. See Section 31 23 23 - Fill.

2.2 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Test fill materials in accordance with specified standard before delivery to site.
- C. Nonconforming Materials: Change and retest.
- D. Provide materials of each type from same source or as directed by Architect.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify survey benchmarks and intended elevations for work are as indicated on drawings.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. See Section 31 10 00 for site clearing and topsoil removal.

3.3 TRENCH EXCAVATION

- A. Grade top perimeter of excavation to prevent surface water collection.
- B. Notify Architect of unexpected subsurface conditions and discontinue affected work in area until notified to resume.
- C. General: Cut trenches neat and clean.
 - 1. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- D. Utility Preparation: Rake trench bottom to uniform grade.
 - 1. Remove unsuitable subgrade and backfill.
 - 2. Compact subgrade to density equal to or greater than subsequent fill material requirements.
- E. Maintain trenches and prevent loose soil or rocks from entering.
- F. Slope banks of excavations deeper than 4 feet to angle of repose or less until shored.
- G. Cut trenches wide enough to allow inspection of installed utilities.
- H. Hand trim excavations. Remove loose matter.
- I. Remove excavated material that is unsuitable for re-use from site.
- J. Remove excess excavated material from site.

3.4 FLOWABLE FILL

- A. Completely cover utilities in accordance with NRMCA CLSM.
- B. Do not advance open trench more than 100 feet ahead of installed pipe.
- C. Excavate bottom of trenches maximum of 2 feet wider than outside diameter of pipe or as indicated on plans.
- D. Excavate trenches to depth indicated on drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.
- E. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section or as required by OSHA.
- F. When subsurface materials at bottom of trench are loose or soft, excavate to greater depth as directed by Architect/Engineer until suitable material is encountered. Notify Architect/Engineer, and request instructions prior to excavation.
- G. Cut out soft areas of sub-grade not capable of compaction in place. Backfill with approved fill material and compact to density equal to or greater than requirements for subsequent backfill material.
- H. Correct over excavated areas with compacted backfill as specified for authorized excavation or replace with fill concrete as directed by Architect/Engineer.

3.5 PREPARATION FOR UTILITY PLACEMENT

- A. Cut out soft areas of subgrade not capable of compaction in place. Backfill with general fill.
- B. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- C. Until ready to backfill, maintain excavations and prevent loose soil from falling into excavation.

3.6 BACKFILL AND COMPACTION

- A. Backfill to contours and elevations indicated on drawings using unfrozen materials.
- B. Fill to subgrade elevations unless otherwise indicated on drawings.
- C. Employ placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen, or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact material in equal continuous layers not exceeding 6 inches compacted depth.
- G. Correct areas that are over-excavated.
 - 1. Other Areas: Backfill, flush to required elevation, compacted to minimum 97 percent of maximum dry density.
- H. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 97 percent of maximum dry density.
 - 2. At Other Locations: 95 percent of maximum dry density.
- I. Reshape and re-compact fills subjected to vehicular traffic.
- J. Place geotextile fabric over bedding fill prior to placing subsequent fill materials.
- K. Place fill material in continuous layers and compact in accordance with schedule at end of this section.
- L. Employ placement method that does not disturb or damage foundation perimeter drainage, utilities in trench, and other below grade improvements.
- M. Do not leave open trenching at end of working day.
- N. Protect open trenches at all times during installation of trenching.

3.7 TOLERANCES

- A. See Section 01 40 00 - Quality Requirements: Tolerances.
- B. Maximum Variation from Top Surface of General Backfilling: Plus or minus 1 inch from required elevations.
- C. Maximum Variation from Top Surface of Backfilling Under Paved Areas: Plus or minus 1 inch from required elevations.

3.8 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for general requirements for field inspection and testing.
- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.

- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with ASTM D1557 modified proctor, AASHTO T 180, or ASTM D698 standard proctor.
- D. Nonconforming Work: For failed tests, remove work, replace, and retest.
- E. Frequency of Tests: Backfill mid-point and top.

3.9 CLEANING

- A. Stockpile excavated material re-used in area designated on-site; see Section 31 22 00.
- B. Remove excavated material unsuitable for re-use from site.
- C. Remove excess excavated material from site.

END OF SECTION

SECTION 31 23 16.26
ROCK REMOVAL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Mechanical removal of discovered rock during excavation.
 - 1. Explosives shall not be used.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 16.13 - Trenching.
- D. Section 31 23 23 - Fill: Fill materials.

1.3 DEFINITIONS

- A. Site Rock: Solid mineral material with a volume in excess of 1/3 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel .
- B. Trench Rock: Solid mineral material with a volume in excess of 1/6 cubic yard or solid material that cannot be removed with a 3/4 cubic yard capacity power shovel .
- C. Rock: Solid mineral material of a size that cannot be removed with a 3/4 cubic yard capacity power shovel.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Survey Report: Submit a survey report on conditions of buildings near locations of rock removal.

1.5 SCHEDULING

- A. See Section 01 30 00 - Administrative Requirements for Coordination and project conditions.
- B. Schedule work to avoid working hours or disruption to occupied buildings nearby.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify site conditions and note subsurface irregularities affecting work of this section.

3.2 PREPARATION

- A. Identify required lines, levels, contours, and datum.

3.3 ROCK REMOVAL

- A. Excavate and remove rock by mechanical methods only; use of explosives is prohibited.
- B. Mechanical Methods: Drill holes and utilize expansive tools to fracture rock.
- C. If rock is uncovered requiring the explosives method for rock disintegration, notify the Architect.
- D. Form level bearing at bottom of excavations.
- E. Remove shaled layers to provide sound and unshattered base for footings.
- F. In utility trenches, excavate to 6 inches below invert elevation of pipe and 24 inches wider than pipe diameter.
- G. Remove excavated materials from site.
- H. Correct unauthorized rock removal in accordance with backfilling and compacting requirements of Section 31 23 23.
- I. Correct unauthorized rock removal to directions of Architect.

3.4 FIELD QUALITY CONTROL

- A. Independent agency field inspection will be provided under provisions of Section 01 40 00 - Quality Requirements.

END OF SECTION

SECTION 31 23 19
DEWATERING

PART 1 GENERAL

1.1 SECTION INCLUDES:

- A. Dewatering system.
- B. System operation and maintenance.
- C. Water disposal.

1.2 RELATED SECTIONS:

- A. Section 31 23 16 - Excavation
- B. Section 31 23 16.13 - Trenching
- C. Section 33 05 61 - Concrete Manholes
- D. Section 33 31 13 - Site Sanitary Sewerage Gravity Piping

1.3 REFERENCES STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.

1.4 DEFINITIONS

- A. Dewatering includes the following:
 - 1. Lowering of ground water table and intercepting horizontal water seepage to prevent ground water from entering excavations trenches.
 - 2. Disposing of removed water.

1.5 SYSTEM DESCRIPTION

- A. Provide dewatering system to permit Work to be completed on dry and stable subgrade.
 - 1. Install wells to dewater and relieve hydrostatic pressure within strata.
- B. Furnish standby equipment stored at Project site and ready for immediate use upon failure of dewatering equipment. Provide the following standby equipment:
 - 1. Dewatering Centrifugal Pumps;
 - 2. Dewatering Turbine Pumps;
 - 3. Pump Power Units;
 - 4. Dewatering Jet Eductor Pressure Pumps;
 - 5. Portable Electric Generators;

1.6 PERFORMANCE REQUIREMENTS

- A. Design dewatering systems to:
 - 1. Lower water table within areas of excavation to elevation minimum 2 feet below bottom of excavation to permit Work to be completed on dry and stable subgrade.
 - 2. Relieve hydrostatic pressures in confined water bearing strata below excavation to eliminate risk of uplift or other instability of excavation.
 - 3. Prevent damage to adjacent properties, buildings, structures, utilities, and facilities from construction operations.

4. Prevent loss of fines, quick condition, or softening of foundation subgrade.
5. Maintain stability of sides and bottoms of excavations and trenches.

1.7 SUBMITTALS

- A. Section 01 30 00 - Administrative Requirements: For submittals procedures.
- B. Shop Drawings: Signed and sealed by professional engineer.
 1. Indicate dewatering system layout, well depths, well screen lengths, dewatering pump locations, pipe sizes and capacities, grades, filter sand gradations, surface water control devices, valves, and water disposal method and location.
 2. Indicate primary and standby power system location and capacity.
 3. Indicate layout and depth of monitoring wells and flow measuring devices for system performance measurement.
 4. Include detailed description of dewatering and monitoring system installation procedures and maintenance of equipment.
 5. Include description of emergency procedures to follow when problems arise.
- C. Product Data: Submit data for each of the following:
 1. Dewatering Pumps: Indicate sizes, capacities, priming method, motor characteristics.
- D. Design Data: Signed and sealed by professional engineer.
 1. Indicate design values, analyses, and calculations to support design.
 2. Include description and profile of geology, soil, and groundwater conditions.
- E. Field Reports: Test and monitoring reports as specified in Field Quality Control article.

1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations and depths of capped wells and piping abandoned in place.

1.9 QUALITY ASSURANCE

- A. Comply with authorities having jurisdiction for the following:
 1. Drilling and abandoning of wells used for dewatering systems.
 2. Water discharge and disposal from pumping operations.
- B. Obtain permit from EPA under National Pollutant Discharge Elimination System (NPDES), and/or New York State Department of Environmental Conservation (NYSDEC), State Pollutant Discharge Elimination System (SPDES), General permit for storm water discharge from construction sites.
- C. The Contractor may be required to prepare a Stormwater Pollution Prevention Plan (SWPPP) to gain approval from the NYSDEC for dewatering discharge.
- D. Installer: Company specializing in performing work of this section documented experience and responsible for design, operation, and maintenance of dewatering system.
 1. Assume sole responsibility for dewatering and surface water control systems and for loss or damage resulting from partial or complete failure of protective measures and settlement or resultant damage caused by ground water control operations.
- E. Design, install, and monitor operation of dewatering under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State of New York.

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements.

- B. Convene minimum one week prior to commencing work of this section.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements.
- B. Coordinate work to permit the following construction operations to be completed on dry stable substrate.
 - 1. Excavation for structures specified in Section 31 23 16.
 - 2. Trenching specified in Section 31 23 16.13

PART 2 PRODUCTS

2.1 DEWATERING EQUIPMENT

- A. Select dewatering equipment to meet specified performance requirements.

2.2 MONITORING EQUIPMENT

- A. Flow Measurement: Furnish devices as follows, if required by permit:
 - 1. Pitometer installed on discharge of pipe of from each well.
 - 2. Pitometer installed to measure flow from entire dewatering system.

2.3 ACCESSORIES

- A. Valves and Fittings: Furnish valves and fittings to isolate each well from header pipe and to prevent loss of pump prime.
- B. Grout: Mixture of portland cement and bentonite clay or sand suitable for sealing abandoned wells and piping.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements.
- B. Call Local Utility One Call Center @ 811 in the State of New York, not less than three working days before performing Work.
 - 1. Request underground utilities to be located and marked within and surrounding construction areas.

3.2 PREPARATION

- A. Protect existing adjacent buildings, structures, and improvements from damage caused by dewatering operations.

3.3 DEWATERING SYSTEM

- A. Install dewatering system in accordance with shop drawings, and industry standards.
- B. Locate system components to allow continuous dewatering operations without interfering with installation of permanent Work and existing public rights-of-way, sidewalks, and adjacent buildings, structures, and improvements.

- C. Install self jetting well points in sizes indicated by driving and jetting to depth indicated.
- D. While drilling and installing well keep bore hole filled with natural or organic drilling fluid. Bentonite clay drilling fluid is not permitted.
- E. Attach well screen to riser pipe. Attach centralizers to riser pipe at maximum 20 feet spacing to keep screen and riser centered in bore hole. Insert well screen and riser pipe into well to elevation indicated.
- F. Install sand filter surrounding well screen and to minimum 2 feet above top of well screen.
- G. Develop wells by over pumping to remove clay, silt, and sand from well screen and immediate vicinity of bore hole.
- H. Test well for proper water flow through well screen and pumping rate for dewatering system operation. Repeat development until well meets performance requirements.
- I. Cover and seal top of well until pump is installed.
- J. Install pumps in accordance with manufacturer's instructions.

3.4 SYSTEM OPERATION AND MAINTENANCE

- A. Operate dewatering system continuously until backfilling is complete.
- B. Provide 24-hour supervision of dewatering system by personnel skilled in operation, maintenance, and replacement of system components.
- C. Conduct daily observation of dewatering system and monitoring system. Make required repairs and perform scheduled maintenance.
- D. Fill fuel tanks before tanks reach 25 percent capacity.
- E. Start emergency generators at least twice each week to check operating condition.
- F. When dewatering system cannot control water within excavation, notify Architect/Engineer and stop excavation work.
 - 1. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.
 - 2. Demonstrate dewatering system operation complies with performance requirements before resuming excavation operations.
- G. Modify dewatering and surface water control systems when operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, or adjacent water wells.
- H. Correct unanticipated pressure conditions affecting dewatering system performance.
- I. Do not discontinue dewatering operations without Architect/Engineer's approval.

3.5 WATER DISPOSAL

- A. Discharge water into drainage channels and settling basins.

3.6 SYSTEM REMOVAL

- A. Remove dewatering system after dewatering operations are discontinued.
- B. Cut off and cap abandoned wells minimum 36 inches below completed subgrade elevation.
- C. Fill abandoned piping with grout.
- D. Repair damage caused by dewatering and surface water control systems or resulting from failure of systems to protect property.

- E. Submit a Notice of Termination (NOT) to NYSDEC

3.7 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Monitor ground water discharge for contamination while performing pumping in vicinity of potentially contaminated sites. Sample and test water weekly for contaminants.
- C. Survey existing adjacent buildings, structures, and improvements weekly to detect movement in comparison to original elevations during dewatering operations.
 - 1. Notify Architect/Engineer immediately of measured movement.
- D. Submit initial installation reports including the following:
 - 1. Installation and development reports and pumps.
 - 2. Initial dewatering flow rates.
- E. Submit weekly monitoring reports including the following:
 - 1. Dewatering flow rates.
 - 2. Test reports of discharge water analysis.
 - 3. Maintenance records for dewatering and surface water control systems.

END OF SECTION

SECTION 31 23 23
FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Filling, backfilling, and compacting for footings, slabs-on-grade, paving, and utilities within the building.
- B. Backfilling and compacting for utilities outside the building to utility main connections.
- C. Filling holes, pits, and excavations generated as a result of removal (demolition) operations.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Site grading.
- B. Section 31 23 16 - Excavation: Removal and handling of soil to be re-used.
- C. Section 31 23 16.13 - Trenching: Excavating for utility trenches outside the building to utility main connections.
- D. Section 31 37 00 - Riprap.
- E. Section 32 91 19 - Landscape Grading.

1.3 DEFINITIONS

- A. Finish Grade Elevations: Indicated on drawings.
- B. Subgrade Elevations: 6 inches below finish grade elevations indicated on drawings, unless otherwise indicated.

1.4 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop; 2022, with Errata .
- B. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2019.
- C. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- D. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2015, with Editorial Revision (2016).
- E. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- F. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2015.
- G. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Soil Samples: 10 pounds sample of each type of fill; submit in air-tight containers to testing laboratory.
 - 1. Provide test of topsoil at a rate of one sample per 100 cubic yards.
 - 2. Stockpiled on-site topsoil shall be sampled from multiple locations within the stockpile.
- C. Materials Sources: Submit name of imported materials source.
- D. Fill Composition Test Reports: Results of laboratory tests on proposed and actual materials used.
 - 1. Fill Composition Test Reports shall be conducted within twelve months prior to submission.
- E. Compaction Density Test Reports.
- F. Testing Agency Qualification Statement.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When fill materials need to be stored on site, locate stockpiles where designated.
 - 1. Separate differing materials with dividers or stockpile separately to prevent intermixing.
 - 2. Prevent contamination.
 - 3. Protect stockpiles from erosion, deterioration, and offsite impacts of materials.

1.8 WARRANTY

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

PART 2 PRODUCTS

2.1 FILL MATERIALS

- A. General Fill: Native or imported material.
 - 1. Material used to meet grade, unless otherwise noted.
 - 2. Free of lumps larger than 3 inches, rocks larger than 3 inches, organics, trash, and debris.
 - 3. Complying with ASTM D2487 Group Symbol GW, GP, GM, SM, SW, or SP.
- B. Select Native Fill: Subsoil excavated on-site.
 - 1. Ungraded.
 - 2. Free of lumps larger than 6 inches, rocks larger than 6 inches, organics, trash, and debris.
 - 3. Complying with ASTM D2487 Group Symbol GW, GP, GM, SM, SW, or SP.
- C. Structural Fill: Conforming to DOT Standards in the State of New York.
 - 1. Structural fill shall meet all requirements specified for Type 2, (Item 733-0402) of the NYSDOT Standard Specification.
- D. Granular Fill: Coarse aggregate, conforming to DOT Standards in the State of New York.
 - 1. Granular fill shall meet all requirements specified for Type 2 (Crushed Ledgerock) or Type 4 Subbase in the NYSDOT Standard Specification.
 - a. Where use of recycled materials is indicated on Drawings, refer to NYSDOT Standard Specifications (Section 733-19 - Recycled Materials Approved for Use as Earthwork Material).
- E. Granular Fill - Pea Gravel: Natural stone; washed, free of clay, shale, organic matter.

- F. Sand- Fill Type Cushion Sand: Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter.
1. Graded in accordance with ASTM C136/C136M; within the following limits:
 - a. 1/4 inch sieve: 100 percent passing.
 - b. No. 50 sieve: 0 to 35 percent passing.
 - c. No. 100 sieve: 0 to 10 percent passing.

G. Topsoil: See Section 32 91 19.

H. Drainage Fill: Material shall consist of crushed stone or screened gravel:

1. Under Drain Filter: Meeting all requirements specified for Type 1, (Item 733-2001) of the NYSDOT Standard Specification:

U.S. Sieve No.	Percent Passing by Weight
1 inch	100
1/2 inch	30-100
1/4 inch	0-30
No. 10	0-10
No 20	0-5

- I. Pipe Bedding Stone: Material shall consist of crushed stone:
1. Meeting all requirements specified for Type 1 and Type 2 (Item 703-4) of the NYSDOT Standard Specification mixed in a 50/50 proportion.

2.2 ACCESSORIES

- A. Geotextile Fabric: Non-biodegradable, woven, fabric ; 500X manufactured by Mirafi , or approved equal.
- B. Filter Fabric: Non-biodegradable, non-woven, fabric; Mirafi 140N, or approved equal.
- C. Geotextile Fabric for Perforated Drain Pipe: Non-biodegradable, non-woven, fabric; Mirafi 140N, or approved equal.

2.3 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for testing and analysis of soil material.
- B. Where fill materials are specified by reference to a specific standard, test and analyze samples for compliance before delivery to site.
- C. If tests indicate materials do not meet specified requirements, change material and retest.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the Work are as indicated.
- B. Identify required lines, levels, contours, and datum locations.
- C. See Section 31 22 00 for additional requirements.
- D. Verify subdrainage, dampproofing, or waterproofing installation has been inspected.
- E. Verify areas to be filled are not compromised with surface or ground water.

3.2 PREPARATION

- A. Scarify subgrade surface to a depth of 8 inches.
- B. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Fill Type directed by Owner's Representative.
- C. Compact subgrade to density equal to or greater than requirements for subsequent fill material.
- D. Until ready to fill, maintain excavations and prevent loose soil from falling into excavation.
- E. Under structural elements and paving, the subgrade and subbase shall be proof rolled. Contact Engineer or Owners representative 24 hours before testing. If subgrade stabilization or undercutting is designed for the project, then proof rolling shall be used to verify the undercut replacement material stability.
- F. Proof rolling deflections and soil conditions that are observed during construction determine if the planned subgrade treatment must be adjusted. Adjustment of subgrade treatment to fit field conditions is essential and is the responsibility of the contractor.
- G. When rutting and deflection occur under wheels of 10-wheel dump truck engineer or representative will require corrective action.
- H. Improve subbase or subgrade by undercutting wet material, aeration of wet soil or use of additional subbase material. Compact material and proof roll again.
- I. Proof roll to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.3 FILLING

- A. Fill to contours and elevations indicated using unfrozen materials.
- B. Fill up to subgrade elevations unless otherwise indicated.
- C. Employ a placement method that does not disturb or damage other work.
- D. Systematically fill to allow maximum time for natural settlement. Do not fill over porous, wet, frozen or spongy subgrade surfaces.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Granular Fill: Place and compact materials in equal continuous layers not exceeding 6 inches compacted depth.
- G. Slope grade away from building minimum 2 percent slope for minimum distance of 5 feet , unless noted otherwise. Make gradual grade changes. Blend slope into level areas.
- H. Correct areas that are over-excavated.
 - 1. Load-bearing foundation surfaces: Use structural fill, flush to required elevation, compacted to 95 percent of maximum dry density.
 - 2. Other areas: Use general fill, flush to required elevation, compacted to minimum 95 percent of maximum dry density.
- I. Compaction Density Unless Otherwise Specified or Indicated:
 - 1. Under paving, slabs-on-grade, and similar construction: 95 percent of maximum dry density.
- J. Reshape and re-compact fills subjected to vehicular traffic.
- K. Maintain temporary means and methods, as required, to remove all water while fill is being placed as required, or until directed by the Architect. Remove and replace soils deemed unsuitable by classification and which are excessively moist due to lack of dewatering or surface water control.

- L. Remove surplus backfill materials from site.

3.4 FILL AT SPECIFIC LOCATIONS

- A. Use fill type indicated unless otherwise indicated in the geotechnical report.
- B. Structural Fill under building footprints:
 - 1. Use structural fill.
 - 2. Fill up to subgrade elevations.
 - 3. Maximum depth per lift: 8 inches, compacted.
 - 4. Compact to minimum 95 percent of maximum dry density.
- C. At Foundation Walls and Footings:
 - 1. Use structural fill.
 - 2. Fill up to subgrade elevation.
 - 3. Maximum depth per lift: 8 inches, compacted.
 - 4. Compact each lift to 95 percent of maximum dry density unless otherwise specified in the geotechnical report.
 - 5. Do not backfill against unsupported foundation walls.
 - 6. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- D. Over Subdrainage Piping at Foundation Perimeter:
 - 1. Drainage fill and geotextile: Section 31 05 19.
 - 2. Cover drainage fill with structural fill.
 - 3. Compact to 95 percent of maximum dry density.
- E. Over Buried Utility Piping, Conduits, and Duct Bank in Trenches:
 - 1. Bedding: Use Fill Type indicated on Drawings.
 - 2. Cover with Select Native fill unless otherwise indicated.
 - 3. Fill up to subgrade elevation.
 - 4. Compact in maximum 8 inch lifts to 95 percent of maximum dry density.
- F. Around and Over Underground Tanks:
 - 1. Use initial fill of sand.
 - a. Compact to 95 percent of maximum dry density.
 - 2. Complete with general fill.
 - a. Compact to 95 percent of maximum dry density.
- G. At Lawn Areas:
 - 1. Use general fill.
 - 2. Compact to 95 percent of maximum dry density.
 - 3. See Section 32 91 19 for topsoil placement.
- H. At French Drains:
 - 1. Use granular fill.
 - 2. Compact to 95 percent of maximum dry density.

3.5 TOLERANCES

- A. Top Surface of General Filling: Plus or minus 1 inch from required elevations.
- B. Top Surface of Filling Under Paved Areas: Plus or minus 1 inch from required elevations.
- C. Top Surface of Filling Within Building Areas: Plus or minus 1/2 inch from required elevations.

3.6 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection and testing.

- B. Perform compaction density testing on compacted fill in accordance with ASTM D1556, ASTM D2167, ASTM D3017, or ASTM D6938. Contractor shall be responsible for providing compaction testing as part of their base bid contract. Slab testing shall be every 100 square feet of area or every 50-ft of trench excavation.
- C. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D 1557 ("modified Proctor"), ASTM D 698 ("standard Proctor"), AASHTO T 180, ASTM D 1557 ("modified Proctor"), ASTM D 698 ("standard Proctor"), AASHTO T 180, ASTM D 1557 ("modified Proctor"), or ASTM D 698 ("standard Proctor").
- D. If tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Frequency of Tests: 1 per 2500 sq. ft, or as directed by Engineer.
- F. Proof roll compacted fill at surfaces that will be under slabs-on-grade, pavers, and paving.

3.7 CLEANING

- A. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.
- B. Remove unused stockpiled materials, leave area in a clean and neat condition. Grade stockpile area to prevent standing surface water.
- C. Leave borrow areas in a clean and neat condition. Grade to prevent standing surface water.

3.8 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished work.
- B. Reshape and re-compact fills subjected to vehicular traffic.

END OF SECTION

SECTION 31 23 23.33
FLOWABLE FILL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Controlled low strength material (CLSM)

1.2 RELATED REQUIREMENTS

- A. Section 31 23 16.13 - Trenching
- B. Section 31 23 19 - Dewatering
- C. Section 31 23 23 - Fill - Backfilling and Compacting for Utilities

1.3 REFERENCE STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.
- B. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- C. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- D. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- E. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019, with Editorial Revision (2022).
- F. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.
- G. ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength (CLSM) Test Cylinders.
- H. ASTM D5971, Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material.
- I. ASTM D6023, Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material (CLSM).
- J. ASTM D6024, Standard Test Method for Ball Drop on Controlled Low-Strength Material (CLSM) to Determine Suitability for Load Application.

1.4 SUBMITTALS

- A. A minimum of two (2) days prior to starting CLSM WORK. Provide product data on the following:
 - 1. CLSM mix design
 - 2. Fly Ash
 - 3. Admixtures

PART 2 PRODUCTS

2.1 MATERIALS

- A. General:

1. The CLSM bedding shall consist of a mixture of sand, coarse aggregate, cement and water.
 2. Fly ash and approved admixtures may be used to obtain the required properties of the mix.
 3. The mix shall have good workability and flowability with self-compacting and self-leveling characteristics.
 4. No changes shall be made in the amounts or sources of the approved mix ingredients without the approval of Engineer.
 5. Product inspection and field-testing of the approved mix may be made by, or on behalf of, Owner.
- B. Cement: All cement used shall be Type II Portland cement which shall conform to the requirements of ASTM C150/C150M.
- C. Fly Ash: Fly ash may be either Class C or Class F. The fly ash shall conform to ASTM C618.
- D. Aggregates:
1. Fine Aggregate: All fine aggregate shall conform to the grading and quality requirements of ASTM C33/C33M.
 2. Coarse Aggregate: Coarse aggregate shall conform to the grading and quality requirements of ASTM C33/C33M for size No. 476, No. 57, or No. 67.
- E. Water: The batch mixing water and mixer washout water shall conform to the requirements of ASTM C494/C494M.
- F. Admixtures:
1. Chemical admixtures that do not contain calcium chloride and conform to ASTM C494/C494M for concrete may be used in the CLSM mix.
 2. All chemical admixtures shall be compatible with the cement and all other admixtures in the batch.
- G. CLSM Proportions:
1. Strength: CLSM shall have a minimum twenty-eight (28) day compressive strength of one hundred (100) psi when molded and cured as in conformance with ASTM D4832.
 2. The CLSM shall have a minimum cement content of fifty (50) pounds per cubic yard. The water-cementitious materials ratio of the mix shall not exceed three and one-half to one (3.5:1).
 3. Air-Entrainment: All CLSM shall be air entrained to a total air content of approximately five percent (5%).
 4. Slump: The minimum slump shall be six (6) inches and the maximum slump shall be eight (8) inches.
 5. Aggregate: Fine aggregate shall be between fifty percent (50%) and sixty percent (60%) by volume of the total aggregates in the CLSM mix.
 6. Consistency:
 - a. The consistency of the CLSM slurry shall be such that the material flows easily into all openings between the pipe and the lower portion of the trench.
 - b. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CLSM from flowing down the trench.
 - c. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.

PART 3 EXECUTION

3.1 GENERAL

- A. CLSM shall be placed as closely behind pipe laying operations as possible.
- B. CLSM shall not be placed, if, in the judgment of Engineer, weather conditions are unsuitable.
- C. CLSM shall not be placed when the trench bottom or walls are frozen or contain frozen materials.

- D. CLSM shall not be placed when the air temperature is below forty degrees Fahrenheit (40°F) unless the air temperature is thirty five degrees Fahrenheit (35°F) or more and the temperature is rising.

3.2 PLACEMENT

- A. Pipe shall be placed on two (2) sandbags and leveled to the proper grade. Precast or other types of rigid pads that constitute a point load are unacceptable.
- B. CLSM shall be placed under the pipe from one side so that it flows under the pipe until it appears on the other side.
 - 1. CLSM shall be added to both sides of the pipe until it completely fills the space between the pipe and the sides of the trench, to the depths shown in the DRAWINGS.
 - 2. Rodding, mechanical vibration and compaction of CLSM shall be performed to assist in consolidating the CLSM.
- C. When required to prevent uplift, the CLSM shall be placed in two (2) stages as required, allowing sufficient time for the initial set of the first stage before the remainder is placed.
- D. CLSM shall be deposited as nearly as practical in its final position and in no way disturb the pipe trench or cause foreign material to become mixed with the CLSM.
- E. Soil backfill shall not be placed until the CLSM has reached the initial set.
 - 1. If backfill is not to be placed over the CLSM within eight (8) hours, a six-inch (6") cover of moist earth shall be placed over the CLSM surface.
 - 2. If the air temperature is fifty degrees Fahrenheit (50°F) or less, the moist earth cover should be at least eighteen inches (18") thick.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Riprap placed loose.
- B. General riprap.
- C. Geotextile filter fabric.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 23 - Fill.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Manufacturer's data for weight, bag type, and approximate dimensions.
 - 2. Manufacturer's data, including characteristics of articulating concrete block unit, dimensions, and special shapes.
 - 3. Manufacturer's data on each geosynthetic product used, including physical properties and seaming materials.
- C. Test Reports: Sieve analysis of bedding material.
- D. Manufacturer's Instructions:
 - 1. Special installation instructions for geosynthetic materials.

1.4 QUALITY ASSURANCE

- A. Perform work in accordance with the Department of Transportation Standards in the State of New York
- B. Maintain one copy of [all construction] documents on site.

PART 2 PRODUCTS

2.1 GENERAL RIPRAP

- A. Riprap: Provide in accordance with Department of Transportation Standards in the State of New York.

2.2 GEOTEXTILE FILTER FABRIC

- A. Geotextile Fabric: Non-biodegradable, woven , meeting Department of Transportation Standards in the State of New York.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify survey benchmarks and intended elevations for work are as indicated on plans.
- B. Identify required lines, levels, contours, and datum locations.
- C. Verify riprap areas are uncompromised with surface or groundwater.
- D. Do not place riprap over frozen or spongy subgrade surfaces.

3.2 PREPARATION

- A. Grade riprap areas to indicated elevations, allowing for riprap thickness. Remove organic materials and compact.

3.3 PLACEMENT

- A. Perform Work in accordance with Department of Transportation Standards in the State of New York.
- B. Place in full course lifts starting at slope base and working uphill.
- C. Installed Thickness: See Contract Documents for actual thickness.

3.4 GEOTEXTILE OR BEDDING CONTACT INSTALLATION

- A. Geotextile Filter Fabric Placement:
 - 1. Install in accordance with manufacturer's recommendations.
 - 2. Edges:
 - a. Overlapped 2 feet (610 mm), minimum.
 - b. Field sewn at 80 percent fabric strength, minimum.
 - 3. Repair or replace fabric damaged during installation.

END OF SECTION

SECTION 32 01 90
OPERATION AND MAINTENANCE OF PLANTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Maintain plants in manner that promotes health, growth, color and appearance, to quality levels specified; replace dead, dying, and damaged plants at no extra cost to Owner.
 - 1. It is Contractor's responsibility to determine type and quantity of soil amendments and fertilizer required.
 - 2. Perform soil analysis to determine type and quantity of soil amendments; test enough soil samples to obtain a comprehensive analysis; submit reports.
- B. Maintain newly planted landscape plants, including turf (lawns), turf (playfields), and trees.
- C. Maintain established landscape plants, including turf (lawns) and turf (playfields).
- D. Clean up landscaped areas.
- E. Maintenance Period
 - 1. The date of installation to the date upon which the new planting are accepted as complete by Architect.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading.
- B. Section 32 91 19 - Landscape Grading.
- C. Section 32 92 19 - Seeding.
- D. Section 32 92 23 - Sodding.
- E. Section 32 93 00 - Plants.

1.3 REFERENCE STANDARDS

- A. ANSI A300 Part 1 - American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning); 2017.
- B. ANSI Z133.1 - American National Standard for Arboricultural Operations - Safety Requirements; 2017.
- C. ASTM D4972 - Standard Test Methods for pH of Soils; 2019.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Soil Tests and Analysis: Submit report showing number of samples, test results, and recommendations for soil amendments and fertilizer.
- C. Product Data: Manufacturer's data sheets on each fertilizer, herbicide, pesticide, and other chemical material to be used, showing trade name, chemical composition, mixing instructions, recommended application rate, storage and handling instructions, and application instructions.
 - 1. Pesticides and Herbicides: Also include U.S. EPA registration number and Material Safety Data Sheets.

- D. Shop Drawings:
 - 1. Maintenance plan.
 - 2. Recommendations of the local Cooperative Extension Service office for maintenance and care of turf.
 - 3. Pesticide application plan; obtain approval of Owner for each individual pesticide application.
- E. Installer Qualifications: As specified.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Maintenance Contractor: The contractual entity that performed the planting installation.
 - 2. Pruners: Certified member, or supervised by certified member, of International Society of Arboriculture.
 - 3. Herbicide Applicators: Certified by authorities having jurisdiction.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver U.S. EPA-controlled materials to site in original containers with legible labels indicating registration number and registered uses.
- B. Deliver fertilizer and manufactured soil amendments to site in original containers bearing manufacturer's chemical analysis, name, trade name or trademark, and indication of compliance with applicable state and federal laws and regulations ; alternatively, bulk delivery with equivalent certificate is acceptable.
- C. Store fertilizer, soil amendments, and mulch in dry locations away from contaminants.
- D. Do not store pesticides, herbicides, or other chemical treatment materials in locations where they could damage seeds or plants.

PART 2 PRODUCTS

2.1 FERTILIZERS AND SOIL AMENDMENTS

- A. Fertilizers: Free flowing granular organic type containing nitrogen, phosphorus, and potassium, plus trace minerals and micro-nutrients; controlled release type is preferred.
 - 1. Determine type and quantity based on soil analysis.
 - 2. Non-Turf Plant Fertilizer: As specified in Section 32 93 00.
- B. Soil Amendments: Type and quantity as required to achieve specified results, based on soil analysis.

2.2 APPLIED MATERIALS

- A. Organic Mulch: Maintain general appearance of existing mulched areas; use one of the following types:
 - 1. Shredded hardwood ranging in size from 1/2 inch to one inch.
- B. Inorganic Mulch: Match existing mulched areas.
- C. Water: Suitable for irrigation; Owner's water supply may be used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. If soil analysis has not already been performed, take sufficient samples to obtain a comprehensive analysis; perform analysis in accordance with ASTM D4972.

3.2 LANDSCAPE MAINTENANCE - GENERAL

- A. Obtain and follow the maintenance instructions provided by the installer of new plant materials.
- B. Protect existing vegetation, pavements, and facilities from damage due to maintenance activities; restore damaged items to original condition or replace, at no extra cost to Owner.
- C. General Cleanup: Remove debris from all landscape areas at least once a week and from turf areas before each mowing.
 - 1. Debris consists of trash, rubbish, dropped leaves, downed branches and limbs of all sizes, dead vegetation, rocks, and other material not belonging in landscaped areas.
 - 2. Remove debris from site and dispose of properly.
- D. Watering, Soil Erosion, and Sedimentation Control: Comply with federal, state, local, and other regulations in force; prevent over-watering, run-off, erosion, puddling, and ponding.
 - 1. Repair temporary erosion control mechanisms provided by others.
 - 2. Repair eroded areas and replant, when caused by inadequate maintenance.
 - 3. Prevent sediment from entering storm drains.
- E. Trees: Exercise care to avoid girdling trees; provide protective collars if necessary; remove protective collars at end of maintenance period.
- F. Fertilizing: Apply fertilizer only when necessary.
- G. Drainage Channels: Remove obstructions in gutters, catch basins, storm drain inlets, yard drains, swales, ditches, and overflows.
 - 1. Remove grates from catch basins to clean.
 - 2. Prevent encroachment of other vegetation on turfed surface drainage channels.
- H. Health Maintenance: Inspect all plants regularly for health:
 - 1. Eradicate diseases and damaging pests, regardless of severity or speed of effect.
 - 2. Treat accidental injuries and abrasions.
 - 3. If a plant is unhealthy but not yet dead, according to specified definitions, determine reason(s) and take remedial action immediately.
 - 4. Remove dead plants immediately upon determining that they are dead.
- I. Pesticide and Herbicide Application: Comply with manufacturer's instructions and recommendations and applicable regulations.
 - 1. Obtain Owner's approval prior to each application.
 - 2. Apply in manner to prevent injury to personnel and damage to property due to either direct spray or drifting, both on and off Owner's property.
 - 3. Use backflow preventers on hose bibbs used for mixing water; prevent spills.
 - 4. Inspect equipment daily before application; repair leaks, clogs, wear, and damage.
 - 5. Do not dispose of excess mixed material, unmixed material, containers, residue, rinse water, or contaminated articles on site; dispose of off site in legal manner.
 - 6. Rinse water may be used as mix water for next batch of same formulation.
 - 7. Contractor is responsible for all recordkeeping, submissions, and reports required by laws and regulations.
- J. Replanting: Perform replacement and replanting immediately upon removal of dead plant.

3.3 IRRIGATION

- A. Irrigation: Do not allow plants to wilt; apply water as required to supplement rainfall; do not waste water; do not water plants or areas not needing water; do not water during rainfall; shut off water flow when finished; repair leaks.
 - 1. No automatic irrigation system is available; provide hoses and other equipment as required.

2. Owner's water source may be used.
3. Do not drive water trucks over septic field, turf, seeded areas, or planting beds.
4. Provide backflow preventers on hose bibbs used for irrigation hoses.

3.4 TURF MAINTENANCE

- A. Maintain turf in manner required to produce turf that is healthy, uniform in color and leaf texture, and free from weeds and other undesirable growth.
 1. Grass Density - Lawns: 20 plants per square foot, minimum.
 2. Bare Spots - Lawns: 2 percent of total area, maximum; 6 inches square, maximum.
 3. Keep turf relatively free of thatch, woody plant roots, diseases, nematodes, soil-borne insects, stones larger than 1 inch in diameter, and other materials detrimental to grass growth.
 4. Limit broadleaf weeds and patches of foreign grass to a maximum of 2 percent of the total area.
- B. Mowing: During growing season(s) mow turf to uniform height, in manner that prevents scalping, rutting, bruising, and uneven or rough cutting.
 1. Prior to mowing clean all debris and leaves from turf surface.
 2. Schedule frequency of mowing so that no more than one-quarter to one-third of grass leaf length is removed during a cutting.
 3. Make each successive mowing at approximately 45 degrees to the previous mowing, if practical.
 4. Cool Season Grasses:
 - a. Reduce mowing height in fall and spring.
 - b. Use rotary type mowers; mulcher type mowers may be used.
 5. Warm Season Grasses:
 - a. Increase mowing height slightly as fall approaches.
 - b. Use reel type mowers; do not use mulcher mowers.
- C. Trimming: Immediately after each mowing, neatly trim perimeter of each turf area and around obstructions within turf area; match height and appearance of adjacent turf.
 1. Adjacent to Pavements: Cut edges of turf to form a distinct, uniform turf edge.
 2. Adjacent to Planting Beds and Permanently Mulched Areas: Cut edges of turf to form a distinct, uniform turf edge.
 3. Around Other Trees and Poles: Where no planting bed or mulched area exists, trimming with string trimmer is acceptable.
 4. At Fences: Trim on both sides of fence.
 5. Irrigation Heads and Valve Boxes: Trim neatly so grass doesn't interfere with operation.
- D. Fertilizer: Apply as recommended by manufacturer and at rate indicated by soil analysis.
 1. Cool Season Grasses: Apply at least once, in Fall before first frost; do not apply high nitrogen fertilizer during Summer; Spring application is optional but must be reduced in quantity.

3.5 TREE AND SHRUB MAINTENANCE

- A. Trees will be considered dead when main leader has died back or when 25 percent or more of crown has died .
- B. Inspect woody plants for health by scraping up to 1/16 inch square area of bark; no green cambium layer below bark shall be evidence of death.
- C. Adjust stakes, guys and turnbuckles, ties, and trunk wrap as required to promote growth and avoid girdling.
- D. Fertilizing: Fertilize all trees at least once during maintenance period, preferably in the Fall; use accepted standards for determining type and method of fertilization.
- E. Pruning: Unless otherwise indicated, prune only to maintain balanced natural shape; follow recommendations of ANSI A300 and ANSI Z133.1 and best local practices for species involved.
- F. Young Trees: Prune at least once during maintenance period at best time to influence ultimate shape and size for the particular species; do not remove or cut off leader.

OPERATION AND MAINTENANCE OF PLANTING

3.6 CLEANING

- A. Remove fallen deciduous leaves in Fall; removal may wait until all leaves have fallen.
- B. Clean adjacent pavements of plant debris and other debris generated by maintenance activities.
- C. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner; Owner's trash collection facilities may be used.
- D. Remove and dispose of general cleanup debris and biodegradable debris in a proper manner.
 - 1. Biodegradable Debris: Owner will designate a compost pile on site where biodegradable debris may be deposited; branches and bark are not considered biodegradable.
 - 2. Branches and Bark: Owner will designate a wood chip storage area; machine-chip all branch and bark debris.
 - 3. Non-Biodegradable Debris: Owner's trash collection facilities may be used.

3.7 CLOSEOUT ACTIVITIES

- A. 20 days prior to end of maintenance period, submit request for final inspection.
- B. Final inspection will be conducted by Architect.

END OF SECTION

SECTION 32 11 20
SUBBASE AND AGGREGATE BASE COURSES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Subbase course.
- B. Geosynthetic reinforcement.
- C. Aggregate base course.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 16.13 - Trenching.
- B. Section 31 23 23 - Fill.
- C. Section 32 13 13 - Concrete Paving.

1.3 REFERENCE STANDARDS

- A. AASHTO T 180 - Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop; 2022, with Errata .
- B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- C. ASTM D1556/D1556M - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method; 2015, with Editorial Revision (2016).
- D. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- E. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method; 2015.
- F. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).
- G. ASTM D3665 - Standard Practice for Random Sampling of Construction Materials; 2012 (Reapproved 2017).
- H. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Test Reports:
 - 1. Aggregate Composition: Results of laboratory tests on proposed and actual materials used.
 - 2. Compaction Density: Results of laboratory tests on compacted course.
- C. Source Quality Control Submittals: Submit name of imported materials source.
- D. Field Quality Control Submittals: Submit compaction density testing results.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. When necessary, store materials on site in advance of need.
- B. When aggregate materials need to be stored on site, locate where indicated on drawings.
- C. Aggregate Storage: Prevent material intermixing, contamination, and deterioration.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Subbase Course:
 - 1. Coarse Aggregate: Coarse aggregate, conforming to Department of Transportation Standards in the State of New York.
 - a. Granular fill shall meet all requirements specified for Type 2 (Crushed Ledgerock) or Type 4 Subbase in the NYSDOT Standard Specification.
 - 1) Where use of recycled materials is indicated on Drawings, refer to NYSDOT Standard Specifications (Section 733-19 - Recycled Materials Approved for Use as Earthwork Material).
- B. Geosynthetic:
 - 1. Geotextile: Nonbiodegradable, woven.
- C. Aggregate Base Course:
 - 1. Coarse Aggregate: Conforming to Department of Transportation Standards in the State of New York.
 - a. Meet all requirements specified for Type 2 (Crushed Ledgerock) or Type 4 Subbase in the NYSDOT Standard Specification.
 - 1) Where use of recycled materials is indicated on Drawings, refer to NYSDOT Standard Specifications (Section 733-19 - Recycled Materials Approved for Use as Earthwork Material).

2.2 SOURCE QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. If tests indicate materials do not meet specified requirements, change material and retest.
- C. Provide materials of each type from same source throughout the Work.
- D. For aggregate materials using classification complying with ASTM D2487, provide testing before delivery to site.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that survey bench marks and intended elevations for the work are as indicated.
- B. Verify substrate has been inspected, and gradients and elevations are correct and dry.

3.2 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and recompact.
- B. Do not place aggregate on soft, muddy, or frozen surfaces.

SUBBASE AND AGGREGATE BASE COURSES

3.3 PLACEMENT

- A. Under Bituminous Concrete Paving:
 - 1. Subbase Compacted Thickness: According to design drawings.
 - 2. Install geosynthetic reinforcement on substrate in accordance with manufacturers instructions.
 - 3. Aggregate Base Compacted Thickness: According to design drawings.
- B. Under Portland Cement Concrete Paving:
 - 1. Subbase Compacted Thickness: According to design drawings.
 - 2. Install geosynthetic reinforcement on substrate in accordance with manufacturers instructions.
 - 3. Aggregate Base Compacted Thickness: According to design drawings.
- C. Place course in maximum 4 inch layers and roller compact to specified density.
- D. Level and contour surfaces to elevations and gradients indicated.
- E. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

- A. Variation From Design Elevation: Within 1/2 inch.
- B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- C. Scheduled Compacted Thickness: Within 1/4 inch.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Subbase Compaction Density Testing: In accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.
- C. Aggregate Base Compaction Density Testing: In accordance with ASTM D1556/D1556M, ASTM D2167, or ASTM D6938.
- D. Evaluate results in relation to compaction curve determined by testing uncompacted material in accordance with AASHTO T 180, ASTM D698 ("standard Proctor"), or ASTM D1557 ("modified Proctor").
- E. Frequency of Tests: In accordance with ASTM D3665.
- F. Remove, replace, and retest work that does not meet specified requirements.
- G. Proof roll compacted aggregate at surfaces going underneath flexible paving.

3.6 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Remove unused materials and grade areas to prevent standing surface water.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single course bituminous concrete paving.
- B. Double course bituminous concrete paving.
- C. Surface sealer.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of site for paving and base.
- B. Section 31 23 23 - Fill: Compacted subgrade for paving.
- C. Section 32 11 20 - Subbase and Aggregate Base Courses.
- D. Section 32 17 23 - Pavement Markings.

1.3 REFERENCE STANDARDS

- A. AI MS-2 - Asphalt Mix Design Methods; 2015.
- B. AI MS-19 - Basic Asphalt Emulsion Manual; 2008.
- C. ASTM D946 - Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction; 2009a.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. See Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene pre-installation meeting a minimum of one week prior to commencing work of this section. Attendance by Architect/ Engineer, Construction Manager, Owner, and Contractor.
- C. Schedule a proof roll of subbase prior to asphalt installation.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Submit proposed mix design of each class of mix for review prior to beginning of Work.
 - 1. Each mix design shall be certified and signed by the respective State Department of Transportation within two years preceding submittal.
- C. Product Data: Provide product data on each additional product required, including, but not limited to primer, tack coat, and joint sealant.
- D. Asphalt Pavement Work Plan: Indicate paving pass width, paving directions, site access, and coordination of timing with other installations.
- E. Installers qualification statement.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with Department of Transportation Standards in the State of New York.
- B. Mixing Plant: Conform to Department of Transportation Standards in the State of New York.
- C. Obtain materials from same source throughout.
- D. Installer Qualifications: Company specializing in performing work of this section with minimum 10 years documented experience.

1.7 FIELD CONDITIONS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not place asphalt when ambient air or base surface temperature is less than 40 degrees F, or surface is wet or frozen, and as further provided:

TEMPERATURE REQUIREMENTS	
Nominal Compacted Lift Thickness	Surface Temperature Minimum
No greater than 1 inch	50 degrees F.
1 inch through 3 inches	45 degrees F.
Greater than 3 inches	40 degrees F.

- C. Place bitumen mixture when temperature is not more than 15 F degrees below bitumen supplier's bill of lading and not more than maximum specified temperature.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Asphalt Cement: Conforming to Department of Transportation Standards in the State of New York.
- B. Aggregate for Binder Course: Conforming to Department of Transportation Standards in the State of New York.
- C. Aggregate for Wearing Course: Conforming to Department of Transportation Standards in the State of New York.
- D. Fine Aggregate: Sand in conformance with Department of Transportation Standards in the State of New York.
- E. Mineral Filler: Finely ground particles of limestone, hydrated lime or other mineral dust, free of foreign matter.
- F. Primer: Homogeneous, medium curing, liquid asphalt in accordance with Department of Transportation Standards in the State of New York.
- G. Tack Coat: Homogeneous and Emulsified asphalt conforming to Department of Transportation Standards in the State of New York.
- H. Joint Sealant: Asphalt joint sealant meeting ASTM D6690 Type II or IV requirements.
- I. Seal Coat: Al MS-19, Seal Master LV concentrate pavement sealer. Manufactured by SealMaster, 800-395-7325, www.sealmaster.net or approved equal.

2.2 ASPHALT PAVING MIXES AND MIX DESIGN

- A. Use dry material to avoid foaming. Mix uniformly.
- B. Binder Course: State of New York Highways standards: Superpave 25mm Binder.

- C. Wearing Course: State of New York Highways standards: Superpave 9.5mm Top Course.
- D. Submit proposed mix design of each class of mix for review prior to beginning of work.

2.3 SOURCE QUALITY CONTROL

- A. Test mix design and samples in accordance with AI MS-2.
- B. Section 01 40 00 - Quality Requirements: Testing, inspection and analysis requirements.

2.4 EQUIPMENT

- A. Hauling Equipment
 - 1. Trucks used for hauling asphalt shall have clean, smooth, tight metal beds.
 - a. Any debris from previous loads hauled shall be removed.
 - 2. The inside of the truck box shall be coated with a Department of Transportation approved release agent.
 - a. Petroleum products, (including but not limited to fuel oil, diesel fuel, kerosene, and gasoline) or solvents shall not be used.
 - 3. Trucks shall be equipped with waterproof covers that totally cover the asphalt load, the front of which is attached to prevent wind from entering under tarp during transport.
- B. Pavers
 - 1. Units shall be self-propelled and include receiving hopper, transfer system, and activated screed.
 - 2. Units shall provide automatic slope control.
 - 3. Units shall be equipped with screed heaters and joint pre-heaters.
- C. Rollers
 - 1. Rollers shall be of vibratory or static steel wheel design, of sufficient weight to adequately provide compaction rate specified.
 - 2. Furnish the following minimum roller quantities per project:
 - a. Total Rollers: Two.
 - b. Total Rollers: Three, when tonnage is 300 tons per day or greater.
 - c. In every instance, one of the required rollers shall be of a Vibratory Wheel design.
 - 3. Equipment shall be free from oil leaks.

PART 3 EXECUTION

3.1 EXAMINATION

- A. See Section 01 70 00 - Execution and Closeout Requirements: Verification of existing conditions before starting work.
- B. Verify that compacted subgrade is dry and ready to support paving and imposed loads.
- C. Verify gradients and elevations of base are correct.
- D. Verify that site improvement items scheduled within the paved area, including but not limited to bollards, sign posts, fence posts, gate operator foundations, and any utilities servicing such equipment are installed prior to paving operations.
- E. Verify gutter drainage grilles and frames manhole frames and curbing are installed in correct position and elevation.

3.2 AGGREGATE BASE COURSE

- A. See Section 32 11 20 - Aggregate Base Courses.

3.3 PREPARATION - PRIMER

- A. Apply primer in accordance with manufacturer's instructions and in conformance with Department of Transportation Standards in the State of New York.
 - 1. Primer shall be placed on aggregate base in all Department of Transportation right-of-ways.
- B. Apply primer on aggregate base or subbase at uniform rate of 1/2 gal/sq yd.

3.4 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with manufacturer's instructions.
- B. Apply tack coat in accordance with Department of Transportation Standards in the State of New York.
 - 1. Apply tack coat between all pavement layers within Department of Transportation right-of-ways.
 - 2. Apply tack coat between pavement layers when:
 - a. Pavement is exposed to traffic.
 - b. Pavement is exposed to dirt and dust.
 - c. Forty eight hours have passed between courses.
- C. Apply tack coat on asphalt or concrete surfaces over subgrade surface at uniform rate of .03 to .10 gallons per square yard.
- D. Apply tack coat to all contact surfaces of curbs, gutters, manholes, and adjacent pavement edges.
- E. Paving shall not commence until tack coat emulsion has broken or is tacky to the touch.

3.5 PREPARATION – SURFACE SEALER

- A. Surface must be clean and free of all loose material and dirt.
- B. Pavement surface repairs shall be made with suitable hot or cold asphalt mix.
- C. Cracks shall be filled with hot or cold pour filler.
- D. Treat all grease, oil, gasoline spots or stains with SealMaster Petro Seal or Prep Seal, or approved equal.

3.6 PLACING ASPHALT PAVEMENT - SINGLE COURSE

- A. Install Work in accordance with Department of Transportation Standards in the State of New York.
- B. Place asphalt within 24 hours of applying primer or tack coat.
- C. Install gutter drainage grilles and frames in correct position and elevation.
- D. Place asphalt wearing course to thickness as identified on construction drawings.
- E. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
 - 1. Compaction should occur when asphalt course is between 150 and 185 degrees F.
- F. Perform rolling with consecutive passes to achieve even and smooth finish without roller marks.

3.7 PLACING ASPHALT PAVEMENT - DOUBLE COURSE

- A. Place asphalt binder course within 24 hours of applying primer or tack coat.
- B. Place asphalt wearing course within two hours of placing and compacting binder course.
- C. Install gutter drainage grilles and frames in correct position and elevation.

- D. Compact pavement by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment.
 - 1. Compaction should occur when asphalt course is between 150 and 185 degrees F.
- E. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

3.8 SEAL COAT

- A. Shall be applied by either pressurized spray application equipment or self propelled squeegee equipment. *Pressurized spray equipment shall be capable of spraying pavement sealer with sand added, maintain continuous agitation or mixing capabilities to maintain homogenous consistency of pavement sealer throughout the application process.* Self-propelled squeegee equipment shall have at least 2 squeegee or brush devices(one behind the other).
- B. Hand squeegee and brushes shall be acceptable in areas where practicality prohibits the use of mechanized equipment.
- C. Limitations: Shall not be applied when temperatures are expected to drop below 50 degrees F at anytime within a 24 hour period after application. When indicated to be applied over new asphalt surfaces, such surfaces shall be allowed to cure a minimum of four weeks under ideal weather conditions (70 degrees F) before application of surface sealer.
- D. Mixing procedures for optimum results shall conform to product specifications.
- E. Apply a minimum of 2 coats.
- F. Apply at a rate of .11 to .13 gallon per square yard, (70-82 square feet per gallon) per coat.

3.9 TOLERANCES

- A. Section 01 40 00 - Quality Requirements: Tolerances.
- B. Flatness: Maximum variation of 1/4 inch measured with 10 foot straight edge.
- C. Compacted Thickness: Within 1/4 inch of specified or indicated thickness.
- D. Variation from True Elevation: Within 1/2 inch.

3.10 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for general requirements for quality control.
- B. Provide field inspection and testing. Take samples and perform tests in accordance with Department of Transportation Standards in the State of New York.

3.11 CLOSEOUT ACTIVITIES

- A. See Section 01 70 00 - Execution and Closeout Requirements
- B. Documentation: Provide copies of Truck Loading Slips (bill of lading) for each load of each design mix of asphalt material used on site.

3.12 PROTECTION

- A. Immediately after placement, protect pavement from mechanical injury for 3 days or until surface temperature is less than 140 degrees F.
- B. Surface Sealer drying time: 8 hours max.

END OF SECTION

SECTION 32 12 17
ASPHALT PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Asphalt and concrete paving crack sealants
- B. Hot pour mastics

1.2 RELATED REQUIREMENTS

- A. Section 32 12 16 - Asphalt Paving
- B. Section 32 13 13 - Concrete Paving

1.3 REFERENCE STANDARDS

- A. ASTM D113 - Standard Test Method for Ductility of Asphalt Materials; 2017
- B. ASTM D3111 - Standard Test Method for Flexibility Determination of Hot-Melt Adhesives by Mandrel Bend Test Method
- C. ASTM D36 - Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
- D. ASTM D5078 - Standard Specification for Crack Filler, Hot Applied, for Asphalt Concrete and Portland Cement Concrete Paving.(Reapproved 2016)
- E. ASTM D5329 - Standard Test Methods for Sealants and Fillers, Hot-Applied, for Joints and Cracks in Asphalt Pavements and Portland Cement Concrete Pavements; 2016
- F. ASTM D6690 - Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements; 2015

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work of this section with Owner, Architect, and all other trades involved in the project.
 - 1. Ensure work of this section is scheduled and carried out so as not to limit access to site.
- B. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's product data sheets, performance criteria and installation instructions.
- C. Manufacturer's Instructions: Indicate preparation requirements, application limitations, and environmental conditions required for installation.
- D. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Perform work in accordance with Department of Transportation Standards in the State of New York in DOT Right-of-Ways.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- D. Obtain materials from same source throughout project.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products specified herein to project site in manufacturer's unopened, undamaged packaging..
- B. Store products under cover and elevated above grade, and as recommended by manufacturer.
 - 1. Prevent damage due to moisture, temperature extremes, or contaminants.

1.8 FIELD CONDITIONS

- A. See Section 01 60 00 - Product Requirements,
- B. Ensure all application limitations including manufacturer's, temperature, and weather are within specified limits.

1.9 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide one year manufacturer warranty for each product.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Maxwell Products, Inc.: www.maxwellproducts.com.
- B. P&T Products, Inc.: www.p-tproductsinc.com.
- C. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

- A. Joint Sealants for parking lots and non-DOT right-of-ways.
 - 1. Polymer modified crack and joint sealant
 - 2. Conforming to ASTM D5078
 - 3. Basis of Design Product: Elastoflex 650 by Maxwell Products.
 - a. Or approved equal
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Joint Sealants for DOT right-of-ways.
 - 1. Polymer modified crack and joint sealant
 - 2. Conforming to ASTM D6690 Type I
 - 3. Basis of Design Product: Elastoflex 410 by Maxwell Products.
 - a. Or approved equal
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

- C. Hot Pour Mastic for wide cracks or surface repair:
 - 1. Basis of Design Product: GAP B by Maxwell Products.
 - a. Or approved equal
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that all areas to receive work of this section are available, and conditions are favorable for work to proceed.

3.2 PREPARATION

- A. Prepare cracks for sealing on the same day they are to be sealed. Install suitable traps or devices on the compressed air equipment to prevent moisture and oil from contaminating the joint surfaces. Maintain these devices and see that they are functioning properly.
- B. Hot Air Lance: In order to thoroughly clean and dry cracks of dust, dirt, foreign material, sand and any other extraneous materials immediately prior to sealing joints. Using compressed air no lower than 90 cfm to 185 cfm, the operator shall blow dry the affected cracks to receive the hot pour sealant. To clean and ensure a dry condition, a hot air lance capable of reaching temperatures ranging from a low end 600 degrees F to 2,000 degrees F shall be used. Do not burn, or scorch the adjoining pavement when using a hot air lance.
 - 1. The hot air lance preparation shall not exceed 200 yards in front of the sealing operation. The compressor delivering the pressurized air shall have functional water and oil separators to ensure no moisture is injected into the cracks.

3.3 SEALANT MELTING

- A. Heat and melt the sealant in a melter constructed either as a double boiler filled with a heat-transfer medium between the inner and outer shells, or with internal tubes or coils carrying the sealant through a heated oil bath and into a heated double wall hopper. The melter will be equipped with separate thermometers to indicate the temperature of the heat transfer medium and the sealant material, positive temperature controls and with a mechanical agitator and recirculating pumping of sealant to assure a homogeneous blend of the sealant. Maintain the sealant temperature inside the tank at the manufacturer's recommended pouring temperature as indicated on the material packaging of the sealant.
- B. To ensure proper sealant application temperature check the discharge of the sealant with a non-contact infrared thermometer. Discharge the sealant at a temperature between the manufacturer's recommended pouring and safe heating temperatures indicated on the material packaging.
- C. Sealing is not permitted if the melter and discharge temperatures do not meet with the requirements described above. Circulate the sealant from the discharge hose and the melter to maintain the proper sealant pouring temperature.
- D. Do not use sealant material heated beyond the safe heating temperature. If the manufacturer's recommendations allow the sealant to be reheated or heated in excess of six hours, recharge the melter with fresh material amounting to at least 20 percent of the volume of the material remaining in the melter.

3.4 PLACING JOINT SEALANT

- A. Sealing is to be done when ambient air temperature is at or above 40F. Seal the routed crack by placing the applicator wand in or directly over the recess and carefully discharge the sealant. Strike-off the sealant flush with the pavement surface so that only a narrow thin film of material measuring no wider than 2 inches wide and 1/16 inch thick is allowed on the pavement surface after sealing the reservoir. Properly sealed joints shall be watertight.
- B. A low pressure, light spray of water or a manufacturer recommended barrier spray may be used to accelerate cooling of the sealant and allow traffic on it without tracking. Blotting the sealant with fine aggregate is not allowed.
- C. Remove and dispose sealant in excess of the specified thin "film" dimensions or that has not bonded to both sides of the reservoir.

3.5 WIDE CRACKS AND PATCHING

- A. Cracks wider than one inch, small potholes and other pavement imperfections as outlined by the Engineer are to be repaired and filled with the hot pour mastic.
- B. Preparing the repair areas is the same process used for crack sealing as outlined above. Equipment used for the heating of the mastic shall conform with the same standards outlined for crack sealing with the exception of having any activity requiring the recirculation or pumping of the material. Due to the high abrasive content of the aggregate no pumping can be used. A gravity discharge directly into the repair area or a box screen applicator shall be used to fill and repair the pavement. To install a proper filled and waterproof repair heated flat stock steel shall be used to ensure the material overbids the repair by 2 inches on all sides. The hot steel plate shall be used to smooth the surface of the mastic.
- C. When manufacturers require a primer prior to installation or a finishing stone topping, it shall be applied in accordance with the materials installation instructions supplied by the manufacturer.
- D. No traffic shall be allowed on top of the mastic repair unit the temperature cools to ensure no damage to the repair or oncoming traffic.

3.6 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

3.7 PROTECTION

- A. Protect installed joint sealants and patches from subsequent construction operations.
- B. Protect sealed areas from vehicular and pedestrian traffic until products have set sufficiently to prevent tracking of sealants.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Concrete sidewalks and integral curbs.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 07 92 00 - Joint Sealants: Sealing joints.
- C. Section 31 22 00 - Grading: Preparation of site for paving and base and preparation of subsoil at pavement perimeter for planting.
- D. Section 31 23 23 - Fill: Compacted subbase for paving.
- E. Section 32 12 16 - Asphalt Paving: Asphalt wearing course.
- F. Section 32 17 26 - Tactile Warning Surfacing: Plastic tactile and detectable warning tiles for pedestrian walking surfaces.

1.3 REFERENCE STANDARDS

- A. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- B. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
- C. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- D. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- E. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- G. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
- H. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- I. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2023.
- J. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2017.
- K. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types); 2023.
- L. ASTM D1752 - Standard Specification for Preformed Sponge Rubber, Cork, and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction; 2018 (Reapproved 2023).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on joint filler, admixtures, and curing compound.
- C. Samples: Submit two sample panels, 12 by 12 inch in size illustrating exposed aggregate finish.

PART 2 PRODUCTS

2.1 PAVING ASSEMBLIES

- A. Comply with applicable requirements of Department of Transportation Standards in the State of New York.

2.2 FORM MATERIALS

- A. Form Materials: As specified in Section 03 30 00, conform to ACI SPEC-301.
- B. Joint Filler: Preformed; non-extruding bituminous type (ASTM D1751) or sponge rubber or cork (ASTM D1752).
 - 1. Product:
 - a. WE Cork, Inc; Expansion Joints: www.wecork.com/#sle.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.

2.3 REINFORCEMENT

- A. Reinforcing Steel and Welded Wire Reinforcement: Types specified in Section 03 30 00.
- B. Dowels: ASTM A615/A615M, Grade 40 - 40,000 psi yield strength; deformed billet steel bars; unfinished finish.

2.4 CONCRETE MATERIALS

- A. Obtain cementitious materials from same source throughout.
- B. Concrete Materials: As specified in Section 03 30 00.
- C. Fiber Reinforcement: Synthetic fibers shown to have long-term resistance to deterioration when in contact with alkalis and moisture; 1/2 inch length.

2.5 ACCESSORIES

- A. Curing Compound: Conforming with Department of Transportation Standards in the State of New York.
- B. Liquid Surface Sealer: Conforming with Department of Transportation Standards in the State of New York.
- C. Tactile Warning Surfaces: See Section 32 17 26.

2.6 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.

- C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended by manufacturer.
- D. Fiber Reinforcement: Add to mix at rate of 1.5 pounds per cubic yard, or as recommended by manufacturer for specific project conditions.
- E. Concrete Properties:
 - 1. Compressive strength, when tested in accordance with ASTM C39/C39M at 28 days; 4,000 psi.
 - 2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight.
 - 3. Cement Content: Minimum 605 lb per cubic yard.
 - 4. Water-Cement Ratio: Maximum 40 percent by weight.
 - 5. Total Air Content: 5.0 to 8.0 percent, determined in accordance with ASTM C173/C173M.
 - 6. Maximum Slump: 4 inches.
 - 7. Maximum Aggregate Size: 1 inch.

2.7 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685/C685M. Mix each batch not less than 1-1/2 minutes and not more than 5 minutes.
- B. Transit Mixers: Comply with ASTM C94/C94M.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.

3.2 SUBBASE

- A. See Section 32 11 20 for construction of base course for work of this Section.

3.3 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole frames with oil to prevent bond with concrete pavement.
- C. Notify Architect minimum 24 hours prior to commencement of concreting operations.

3.4 FORMING

- A. Place and secure forms to correct location, dimension, profile, and gradient.
- B. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- C. Place joint filler vertical in position, in straight lines. Secure to formwork during concrete placement.

3.5 REINFORCEMENT

- A. Place reinforcement at as indicated on the construction drawings.
- B. Interrupt reinforcement at expansion joints.

3.6 COLD AND HOT WEATHER CONCRETING

- A. Follow recommendations of ACI PRC-305 when concreting during hot weather.
- B. Follow recommendations of ACI PRC-306 when concreting during cold weather.
- C. Do not place concrete when base surface temperature is less than 40 degrees F, or surface is wet or frozen.

3.7 PLACING CONCRETE

- A. Coordinate installation of snow melting components.
- B. Place concrete in accordance with ACI PRC-304.
- C. Do not place concrete when base surface is wet.
- D. Place concrete using the slip form technique.
- E. Ensure reinforcement, inserts, embedded parts, formed joints are not disturbed during concrete placement.
- F. Place concrete continuously over the full width of the panel and between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.
- G. Place concrete to pattern indicated.

3.8 JOINTS

- A. Align curb, gutter, and sidewalk joints.
- B. Place 1/2 inch wide expansion joints at 20 foot intervals and to separate paving from vertical surfaces and other components and in pattern indicated.
 - 1. Form joints with joint filler extending from bottom of pavement to within 1/4 inch of finished surface.
 - 2. Secure to resist movement by wet concrete.
- C. Provide scored joints.
 - 1. As indicated on plan.
 - 2. At 5 feet intervals.
 - 3. Between sidewalks and curbs.
 - 4. Between curbs and pavement.
 - 5. Scores to be a 2" tooled joint.
- D. Provide keyed joints as indicated.
- E. Saw cut contraction joints 3/16 inch wide at an optimum time after finishing. Cut 1/3 into depth of slab.
- F. Joint Sealants:
 - 1. Apply joint sealants to expansion joints, and other areas indicated.
 - 2. See Section 07 92 00 - Joint Sealants for sealant type and application.
 - 3. In addition to the requirements of 07 92 00, apply sealants prior to first freezing temperatures, and when substrate can be maintained at 40 degrees F, minimum for 48 hours prior to and 72 hours following application.

3.9 FINISHING

- A. Area Paving: Light broom, texture perpendicular to pavement direction.
- B. Sidewalk Paving: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.
- C. Median Barrier: Light broom, texture perpendicular to direction of travel with troweled and radiused edge 1/4 inch radius.

- D. Curbs and Gutters: Light broom, texture parallel to pavement direction.
- E. Inclined Vehicular Ramps: Broomed perpendicular to slope.
- F. Place sealer on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.

3.10 TOLERANCES

- A. Maximum Variation of Surface Flatness: 1/4 inch in 10 ft.
- B. Maximum Variation From True Position: 1/4 inch.

3.11 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
 - 1. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - 2. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - 3. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- B. Compressive Strength Tests: ASTM C39/C39M; for each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
 - 1. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
 - 2. Perform one slump test for each set of test cylinders taken.
- C. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.12 PROTECTION

- A. Immediately after placement, protect pavement from premature drying, excessive hot or cold temperatures, and mechanical injury.
- B. Do not permit pedestrian or vehicular traffic over pavement for 7 days minimum after finishing.

END OF SECTION

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Painted pavement markings.
- B. Temporary Marking Tape.

1.2 RELATED REQUIREMENTS

- A. Section 32 12 16 - Asphalt Paving.
- B. Section 32 13 13 - Concrete Paving.
- C. Section 32 17 26 - Tactile Warning Surfacing.

1.3 REFERENCE STANDARDS

- A. AASHTO MP 24 - Standard Specification for Waterborne White and Yellow Traffic Paints; 2015 (Reapproved 2020).
- B. FHWA MUTCD - Manual on Uniform Traffic Control Devices; 2023.

1.4 ADMINISTRATIVE REQUIREMENTS

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

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate survey control points and pavement markings color and layout.
 - 1. Layout and color shall be Owner approved prior to application.
- C. Product Data: Manufacturer's data sheets on each product to be used.
- D. Certificates: Submit for each batch stating compliance with specified requirements.
 - 1. Painted pavement markings.
- E. Manufacturer's Instructions:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.

1.6 QUALITY ASSURANCE

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

- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience and approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver paint in containers of at least 5 gallons accompanied by batch certificate.
- B. Store products in manufacturer's unopened packaging until ready for installation.

1.8 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Do not apply paint if temperature of surface to be painted or the atmosphere is less than 50 degrees F or more than 95 degrees F.

1.9 SEQUENCING

- A. Allow new pavement surfaces to cure for a period of not less than 30 days before application of markings.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Painted Pavement Markings:
 - 1. Ennis-Flint: www.ennisflintamericas.com.
 - 2. Franklin Paint; HYDROPHAST: www.franklinpaint.com.
 - 3. Ozark Materials, LLC: www.ozarkmaterials.net.
 - 4. Sherwin Williams: www.sherwinwilliams.com.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Temporary Marking Tape:
 - 1. 3M: Stamark: www.3m.com.
 - 2. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 PAINTED PAVEMENT MARKINGS

- A. Painted Pavement Markings: As indicated on drawings.
 - 1. Marking Paint: Latex Based, in accordance with AASHTO MP 24.
 - a. Parking Lots: White.
 - b. Symbols and Text: White.
 - c. Accessible Symbols: Provide blue.
 - 2. Obliterating Paint: Type I, in accordance with AASHTO MP 24.
 - a. Bituminous Pavement: Black.
 - b. Concrete Pavement: Gray.

2.3 TEMPORARY MARKING TAPE

- A. Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Identify existing markings for removal.
- B. Owner verification: Verify by Owner approved shop drawings of new pavement markings prior to beginning application.
 - 1. Final approval by Owner following chalking out, shall be required.
- C. Verification of Conditions: Verify that pavement is dry and ready for installation.
- D. Notify Architect of unsatisfactory conditions before proceeding.

3.2 PREPARATION

- A. Establish survey control points for locating and dimensioning of markings.
- B. Place barricades, warning signs, and flags as necessary to alert approaching traffic and prevent traffic crossing newly painted markings.
- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- D. Clean surfaces prior to installation.
 - 1. Remove dust, dirt, and other debris by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
 - 2. Remove rubber deposits and other coatings adhering to the pavement, by scraping, wire brushing, hydroblasting, sandblasting, mechanical abrasion, or approved chemicals.
 - 3. Remove existing paint markings by mechanical means outlined above.
 - 4. Sandblasting: Use equipment of size and capacity necessary, providing not less than 150 cfm of air at pressure not less than 90 psi at each nozzle used.
 - 5. Provide obliterating paint after mechanical means are completed.
- E. Where oil or grease are present, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application; after cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through the new paint.
- F. Temporary Markings: Apply as directed by Architect.
- G. Apply paint stencils by type and color at necessary intervals.

3.3 INSTALLATION

- A. General:
 - 1. Position pavement markings as indicated on drawings and approved shop drawings.
 - 2. Field location adjustments require approval of Architect and Owner.
 - 3. Allow traffic movement without hindrance.
- B. Painted Pavement Markings:
 - 1. Apply in accordance with manufacturer's instructions using an experienced technician that is thoroughly familiar with equipment, materials, and marking layouts.
 - 2. Obliterating Paint: Apply as necessary to cover existing markings completely.
 - 3. Marking Paint: Apply uniformly, with sharp edges.
 - a. Applications: One coat.
 - b. Wet Film Thickness: 0.015 inch, minimum.
 - c. Stencils: Lay flat against pavement, align with striping, remove after application.
 - d. Length Tolerance: Plus or minus 3 inches.
 - e. Width Tolerance: Plus or minus 1/8 inch.
 - 4. Roadway Traffic Lanes: Use suitable mobile mechanical equipment that provides constant agitation of paint and travels at controlled speeds.
 - a. Conduct operations in such a manner that necessary traffic can move without hindrance.

- b. If paint does not dry within expected time, discontinue paint operations until cause of slow drying is determined and corrected.
 - c. Skip Markings: Synchronize one or more paint "guns" to automatically begin and cut off paint flow; make length of intervals as indicated.
 - d. Use hand application by pneumatic spray for application of paint in areas where a mobile paint applicator cannot be used.
- C. Temporary Pavement Markings: When required or directed by Architect, or where phasing plans and schedules indicate, apply temporary markings of the color(s), width(s) and length(s) as indicated or directed.
 - 1. After temporary marking has served its purpose, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method so that surface to which the marking was applied will not be damaged.
 - 2. At Contractor's option, temporary marking tape may be used in lieu of temporary painted marking; remove unsatisfactory tape and replace with painted markings at no additional cost to Owner.
- D. Plastic Pavement Markings:
 - 1. Install in accordance with manufacturer's instructions in manner necessary to maintain manufacturer's warranty.
 - 2. Install in accordance with State of New York Highway Department standards.
 - 3. Install in accordance with FHWA MUTCD standards.
 - 4. Thermoplastic Markings: Preheat pavement surface to 275 degrees F (135 degrees C). Place markings on pavement smooth and without wrinkles. 1/4 inch (6 mm) maximum gap between adjacent markings. Uniformly heat markings between 400 degrees F (204 degrees C) to 440 degrees F (227 degrees C). Do not overheat, scorch, or disperse embedded glass beads.
 - a. Apply primer according to manufacturer's recommendations.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. If inspections indicate work does not meet specified requirements, rework and reinspect at no cost to Owner.
 - 1. Remove and replace markings that are applied at less than minimum material rates; deviate from true alignment; exceed length and width tolerances; or show light spots, smears, or other deficiencies or irregularities.
 - 2. Remove unsatisfactory markings in a manner to avoid damage to the surface to which the marking was applied by carefully controlled sandblasting, approved grinding equipment, or other approved method.
- C. Allow the pavement marking to set at least the minimum time recommended by manufacturer.

3.5 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals for additional requirements.
- B. Temporary Markings: Remove without damaging surfaces.

3.6 PROTECTION

- A. Prevent approaching traffic from crossing newly applied pavement markings.
- B. Replace damaged or removed markings at no additional cost to Owner.
- C. Preserve survey control points until pavement marking acceptance.

END OF SECTION

SECTION 32 17 26
TACTILE WARNING SURFACING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Cast iron tactile warning surfacing.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 32 17 23 - Pavement Markings.
- C. Section 32 17 29 - Crosswalk Warning Lights and Signs.

1.3 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- C. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- D. ATBCB PROWAG - Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way; 2023.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's product data, standard details, details specific to this project, written installation, and maintenance instructions.
- C. Shop Drawings: Submit plan and detail drawings. Indicate:
 - 1. Locations on project site. Demonstrate compliance with referenced accessibility standards.
 - 2. Sizes and layout.
 - 3. Pattern spacing and orientation.
 - 4. Attachment and fastener details, if applicable.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Warranty: Submit manufacturer warranty; complete forms in Owner's name and register with manufacturer.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with minimum 3 years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver to project site in manufacturer's protective wrapping and in manufacturer's unopened packaging.
- B. Store covered and elevated above grade and in manufacturer's unopened packaging until ready for installation. Maintain at ambient temperature between 40 and 90 degrees F.

1.7 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide standard 10-year warranty against manufacturing defects, breakage, or deformation of cast iron tiles. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Cast Iron Tactile Warning Surfacing:
 - 1. ADA Solutions, a division of SureWerx USA: www.adatale.com/#sle.
 - 2. EqualTile, a brand of Advanced Roadway Manufacturing, Inc: www.equaltile.com/#sle.
 - 3. EJ: www.ejco.com/#sle.
 - 4. Neenah Foundry, a division of Neenah Enterprises, Inc: www.nfco.com/#sle.
 - 5. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 MATERIALS

- A. Cast Iron Tactile Warning Surfacing:
 - 1. Material: Gray cast iron; ASTM A48/A48M, Class 30 A, minimum.
 - 2. Shape: Rectangular and radius.
 - 3. Square Dimensions: 24 inches square.
 - 4. Radius Dimensions: 24 inches wide, 9-foot, 5-inch radius.
 - 5. Pattern: Truncated cones complying with ADA Standards.
 - 6. Joint: Manufacturer standard, bolted connection.
 - 7. Finish: Manufacturer's factory-applied powder coat.
 - 8. Color: As selected by Architect from manufacturer's standard range.

2.3 ACCESSORIES

- A. Fasteners: ASTM A666/A666M, Type 304 stainless steel.
 - 1. Type: Countersunk, color-matched composite sleeve anchors.
 - 2. Size: 1/4 inch diameter and 1-1/2 inches long.
- B. Adhesive: Type recommended and approved by surfacing tile manufacturer.
- C. Sealant: Elastomeric sealant of color to match adjacent surfaces; approved by surfacing tile manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

- A. When installation location is near site boundary or property line, verify required location using property survey.
- B. Verify that work area is ready to receive work:

1. Examine work area with installer present.
 2. If existing conditions are not as required to properly complete the work of this section, notify Architect.
 3. Verify substrate is clean and dry, free of voids, projections, and loose material.
 4. Do not proceed with installation until deficiencies in existing conditions have been corrected.
- C. Verify that dimensions, tolerances, and attachment methods for work in this section are properly coordinated with other work on site.

3.2 PREPARATION

- A. Surface Preparation:
1. Remove dust, oil, grease, curing compounds, sealers, and other substances that may interfere with adhesive bond or sealant adhesion.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's written instructions.
1. Do not install damaged, warped, bowed, dented, abraded, or otherwise defective units.
 2. Do not install when ambient or substrate temperature has been below 40 degrees F during the preceding 8 daylight hours.
- B. Field Adjustment:
1. Locate relative to curb line in accordance with ATBCB PROWAG, Sections 304 and 305.
 2. Orient so dome pattern is aligned with the direction of ramp.
- C. Install units fully seated to substrate, square to straight edges and flat to required slope.
- D. Install units such that the tops of the domes are level to the adjacent concrete at the top and sides of the ramp, and the base of the domes level to the adjacent concrete at the base of the ramp to provide proper drainage and reduce snow clearing damage.
- E. Align units so that tops of adjacent units are flush and joints between units are uniform in width.
- F. Cast in Place:
1. When installing multiple adjacent units, leave 3/16-inch gap between units to allow for expansion.
 2. Tamp and vibrate units as recommended by manufacturer.
 3. Place and position weights on units while concrete cures.
 4. Ensure no voids or air pockets exist between top surface of concrete and underside of units.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Inspect for raised edges and misalignment.
- C. Nonconforming Work: Remove and replace.

3.5 PROTECTION

- A. Protect installed units from traffic, subsequent construction operations or other imposed loads until concrete is fully cured.
- B. Touch-up, repair or replace damaged products prior to Date of Substantial Completion.

END OF SECTION

SECTION 32 17 29
CROSSWALK WARNING LIGHTS AND SIGNS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wiring between components and power and control unit.
- B. Lighted crosswalk warning signs.
- C. Poles for support of devices specified in this section.

1.2 RELATED REQUIREMENTS

- A. Section 01 78 00 - Closeout Submittals: Requirements for submittal of operation and maintenance (O&M) data and warranties.

1.3 REFERENCE STANDARDS

- A. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. FHWA MUTCD - Manual on Uniform Traffic Control Devices; 2023.
- D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
- C. Shop Drawings: Field-measured site drawings showing:
 - 1. Location and alignment of each in-roadway warning light, actuator, and sign.
 - 2. Location of power/control units and method of mounting.
 - 3. Relate location dimensions to some existing construction that will exist when installation begins.
- D. Post-Installation Field Report: Indicating results of inspection after installation.
- E. Manufacturer's Qualification Statement.
- F. Installer's Qualification Statement.
- G. Operation and Maintenance Data: Operating, troubleshooting, repair, and replacement instructions; include parts list, recommended spare parts to keep on hand, and where parts are obtainable.
- H. Warranty: Comply with manufacturer's requirements for activation of warranty; promptly notify Owner of warranty start and end dates; submit warranty terms and conditions.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of experience.
 - 1. Providing products manufactured in the United States.
- B. Installer Qualifications: Manufacturer's own employees or company specializing in installing roadway lighting, traffic lights, or roadway signs with minimum of two years experience and approved by manufacturer.

1.6 FIELD CONDITIONS

- A. Do not install components when ambient temperature is below 40 degrees F or when pavement is wet.

1.7 WARRANTY

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Crosswalk Rectangular Rapid Flashing Beacons, Push Buttons & Mounting Pole Systems
 - 1. Traffic Safety Corp.: www.xwalk.com
 - 2. Substitutions See Section 01 60 00 - Product Requirements

2.2 SYSTEM DESCRIPTION

- A. Provide all components designed and constructed to comprise a complete system that uses flashing lights to warn oncoming vehicles that a pedestrian is in or entering the crosswalk.
 - 1. Comply with applicable provisions of FHWA MUTCD.
 - 2. Comply with applicable provisions of NFPA 70.
 - 3. Comply with and approved by the Department of Transportation standards in the State of New York.
 - 4. Provide lights and configuration so that lights are visible in daylight from distance of 1000 feet, minimum.
 - 5. Applicable crosswalks are indicated on the drawings.

2.3 COMPONENTS

- A. Rectangular Rapid Flashing Beacons
 - 1. Construction: .080 highway grade aluminum/stainless fasteners.
 - 2. LED Modules: 2 arrays of 24 yellow LEDs
 - 3. Dimensions (weight):
 - a. Light Bar: 24.5"L x 2.25"W x 4"H (5 lb.)
 - b. LED Modules: 7.25"L x 3.125"W
 - c. Locking Cabinet: 10.54" x 12.54" x 7.35" (6 lb.)
 - d. Battery: 7" x 3" x 6.5" (15 lb.)
 - 4. Pedestrian Confirmation Light: mount on left or right side of light bar.
 - 5. Power: AC Powe
 - 6. LED Lighting:
 - a. MUTCD Compliant RRFB light bar.
 - b. Wig-Wag + Simultaneous (WW+S) flash pattern.

CROSSWALK WARNING LIGHTS AND SIGNS

- c. Double-Sided with pedestrian confirmation light.
- 7. Activation: Push-buttons
- 8. Locking Cabinet:
 - a. High-impact, UV resistant polycarbonate
 - b. UL/NEMA 4X (IP66)
 - c. Light gray opaque hinged enclosure
 - d. Stainless steel locking latch
 - e. Dimensions: 10.54" x 12.54" x 7.35"
- B. Pushbutton Manual Actuators: ADA Standards compliant stainless steel pushbutton and sign enhanced ; for pole mounting; cast aluminum housing.
 - 1. Sign Text: "Push Button to Turn on Warning Lights"; MUTCD R10-25.
 - 2. Sign Style: Right or left facing figure as applicable.
 - 3. Sign Color: Yellow background with black text.
 - 4. Mounting Height: As required by local authority and ADA standards.
 - 5. Feedback
 - a. Visual: LED
 - b. Latching Mode: LED with PBI-L
 - c. Tactile arrow
 - 6. Electrical:
 - a. Operating Voltage AC: 12-17 VAC
 - 7. Actuator Size: 2 inches.
 - 8. Operating Temperature: Minus 4 to 175 degrees F.
- C. Warning Signs: MUTCD-compliant crosswalk signs.
 - 1. Reuse salvaged signs from site.
 - 2. Sign Style:
 - a. Pedestrian crossing without crosswalk lines; 30 x 30 inches; MUTCD W11-2.
 - b. School crossing without crosswalk lines; 30 x 30 inches; MUTCD S1-1.
 - c. Diagonal down pointing arrow, left or right as indicated; 12 x 24 inches; MUTCD W16-7P.
 - 3. Sign Material: Aluminum coated diamond grade reflective sheeting, 0.08 inch thick.
 - 4. Sign Color: Fluorescent yellow green.
 - 5. Mounting: Bracket for pole mounting, with tamperproof fasteners.
 - 6. Pedestal Poles: 4.5 inch diameter spun aluminum pipe, factory threaded.
 - a. Pole length: 12 feet.
 - b. Provide the following pole accessories:
 - 1) Cast base with access door.
 - 2) Base collar.
 - 3) Base anchorage.
 - 4) Cast cap.
 - 7. Concrete for Pole Footings:
 - a. Concrete for Pole Footings: 4000 psi compressive strength at 28 days.
 - b. Size: Comply with local traffic engineering guidelines and regulations.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify location of all poles prior to placement.

3.2 PREPARATION

- A. Have approved layout and alignment drawings on hand.

3.3 INSTALLATION

CROSSWALK WARNING LIGHTS AND SIGNS

- A. Install in accordance with manufacturer's instructions in manner necessary to maintain manufacturer's warranty.
- B. Install pole bases in accordance with manufacturer's instructions and as indicated in drawings.
 - 1. Base to be installed with access doors facing away from vehicular traffic.
- C. Allow concrete to attain sufficient cure strength prior to proceeding with pole installation.
- D. Mount all required components and signage to poles at heights in compliance with ADA Standards, FHWA MUTCD, and approved shop drawings.
- E. Mount components utilizing stainless steel banding.
- F. Perform electrical work in accordance with manufacturer's written instructions and NFPA 70.
- G. Route cables within pole whenever possible. At locations that cabling penetrates poles, provide rubber grommets to prevent damage to cable, and further provide drip loops.
- H. Test and adjust after installation for proper operation, in accordance with manufacturer's instructions.

3.4 CLEANING AND PROTECTION

- A. Clean installed work to like-new condition.
- B. Protect installed products until completion of project.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate operation of equipment to Owner's designated personnel.

END OF SECTION

SECTION 32 18 23.13
BASEBALL/SOFTBALL INFIELD MIX

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Baseball/ Softball infield mix
- B. Amendments to infield mix
- C. Topdressing of infield mix

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading
- B. Section 31 23 16 - Excavation

1.3 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM F1632 - Standard Test Method for Particle Size Analysis and Sand Shape Grading of Golf Course Putting Green and Sports Field Rootzone Mixes; 2003 (Reapproved 2018).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data sheets for each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Product sample: Submit a 5-pound sample along with a private lab test result indicating the particle size analysis of the material specified. All tests shall be performed in accordance with ASTM F-1632.
- C. Approved Testing Lab: Turf & Soil Diagnostics 35 King Street Trumansburg, NY 14886 (607) 387-5694

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installers of materials specified shall have, at minimum, five successful installations of similar projects and materials. Installers shall be in possession of and demonstrate knowledge of the use of laser guided finishing equipment.
- B. Material: If quality control samples are specified, they shall be completed at a rate of one per 250 tons of material delivered to the jobsite. All tests shall be conducted by the lab specified in Submittals section above. All testing will be compared to and be in accordance with the material specifications provided in Part 2 - Products.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. Basis of Design: DuraEdge Classic Infield Mix; DuraEdge Products, www.duraedge.com
- B. Or Approved Equal
- C. Substitutions: See Section 01 60 00 - Product Requirements

2.2 MATERIALS

- A. DuraEdge Classic Infield Mix is an engineered soil product which is mechanically mixed offsite in a controlled environment using a pugmill-type mixer. This process ensures thorough mixing of the sand and clay components to exact specifications.
- B. Performance Specification
 - 1. Infield mix shall be clean, dry clay mixed with washed mason-type sand resulting in a weed-free mixture that is reddish brown in color having a yield of 1.35 tons per cubic yard when placed loose or 1.5 tons per cubic yard when compacted 85% - 90% on a Standard Proctor Test (ASTM D 698). The material possesses the following particle size analysis:
 - a. Total sand content shall be 70-75 percent.
 - b. The combined amount of sand retained on the medium, coarse and very coarse sieves shall be greater than or equal to 50 percent.
 - c. The combined amount of silt and clay shall be 25-30 percent.
 - d. The ratio of silt divided by clay, otherwise known as the SCR, shall be 0.5 - 1.0.
 - e. No particles greater than 3 millimeters.
 - f. Equal to or less than 5 percent of particles shall be retained on the 2 millimeter.
- C. Amendments
 - 1. Certain amendments are approved for use with DuraEdge Classic Infield Mix and shall be installed at the architect's discretion in accordance with the manufacturer's recommendations. Contact the manufacturer for further instructions.

2.3 EXCESS MATERIALS

- A. Provide the owners' authorized representative with a 10-ton stockpile of material for future use.

PART 3 - EXECUTION

3.1 PROJECT/SITE CONDITIONS

- A. All site work and earthwork shall be performed in accordance with the preceding sections.
- B. Granular fill material shall be installed in accordance with the final 1/2 percent to 1 percent slope, compacted to 90 percent or greater and shall mirror the finish grade in order to ensure an even depth of material once placement has occurred.
- C. Under no circumstances are perforated pipe under drains necessary or recommended for use under any infield skin material. Geotextile fabric is not recommended between the compacted sub-base and the infield skin material.
- D. In certain instances, and where warranted, a survey of the sub-grade elevations shall occur prior to placement of the infield skin material.

3.2 PLACEMENT

- A. Place the material in lifts of 2 to 3 inches and lightly compact until an optimum compaction between 85 and 90 percent is achieved on a standard proctor test (ASTM D 698). Scarify the surface to facilitate bonding of the next lift and repeat until finish grade elevation is achieved. Completing this process as described will minimize settling and improve the performance of the product.

- B. Depth of the material shall be 4 inches for new construction when finished and compacted.

3.3 WATERING

- A. In most cases, the material is delivered with optimum moisture and adding water is not necessary. If unable to achieve optimum compaction, a light application of water may be needed.

3.4 FINISH GRADING

- A. For best results the material shall be finish graded with a laser device that allows accuracy to +/- 1/8 inch. A slope of 1/2 percent to 1 percent shall be placed on the infield surface in order to facilitate surface drainage.

3.5 INSPECTION

- A. The finished surface of the infield shall be smooth and free from any visible dips, humps, bumps or other blemishes which would hinder the removal of water through positive surface drainage. Where warranted, a finished elevation survey shall be conducted to assure proper installation.

3.6 TOPDRESSING

- A. Following successful inspection, topdressing shall be applied to the surface for optimum product performance. This topdressing is either expanded shale or calcined clay product and shall be added at a rate of 0.5 pounds per 1 square foot for maintenance, or 1 pound per 1 square foot for new construction.
- B. Product is either ProSlide Engineered Topdressing (expanded shale) or Turface Pro League Heritage Red Conditioner (calcined clay). Both products are available through DuraEdge Products, Inc., Grove City, PA, (866) 867-0052. Turface is also available through Profile Products LLC, 750 Lake Cook Rd, Suite 440, Buffalo Grove, Ill., (800) 207-6457.

END OF SECTION

SECTION 32 18 23.59
SYNTHETIC COURT SURFACING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Acrylic Athletic Court Resurfacer.
- B. Acrylic Athletic Court Color Finish Coat.
- C. Acrylic Athletic Court Line Paint.

1.2 SUBMITTALS

- A. Product data including technical data sheets for all components used in acrylic color surfacing system.
- B. Certification that materials meet or exceed the requirements specified.
- C. Color samples and complete specifications of acrylic color system proposed.
- D. Installer's Qualification Statement.

1.3 QUALITY ASSURANCE

- A. Installer must be a member of American Sports Builders Association.
- B. All system components shall be free of asbestos, lead, and mercury.
- C. Water used in all mixtures shall be fresh and potable.
- D. No part of the surfacing system shall be applied during a rainfall, or when rainfall is imminent.
- E. Do not apply coatings to a cold surface. Surface and air temperatures must be a minimum of 50 degrees F and rising.
- F. No coatings shall be applied if surface temperatures exceed 130 degrees F.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be delivered to the job site in sealed containers with manufacturer's label affixed.
- B. Store products between 40 and 90°F prior to application.

1.5 WARRANTY

- A. Contractor shall warrant the surface installation against faulty materials or workmanship for a period of two years from the date of acceptance by the Owner. Any defects occurring during the warranty period shall be promptly repaired upon notification at no cost to the Owner.

PART 2 PRODUCTS

2.1 BASIS OF DESIGN

- A. Advanced Polymer Technology; Laykold Advantage Color System: www.advpolytech.com.

2.2 SYSTEM COMPONENTS

- A. Resurfacer and Filler
 - 1. Sand-filled 100% acrylic emulsion to fill and smooth rough pavements.
 - 2. Single- or multi-coat application.
 - 3. Percent solids by weight 52% Minimum.
 - 4. Weight: 10.68 lbs/gal.
 - 5. Color: Same as finish coat.
 - 6. Product: Laykold Advantage NuSurf.
- B. Color Finish Coat
 - 1. Sand-filled pigmented wear-resistant acrylic emulsion.
 - 2. Two coats.
 - 3. Percent solids by weight 49% minimum.
 - 4. Weight: 12.9 (+/-3) lbs/gal.
 - 5. Color: As selected by Architect from manufacturer's full line.
 - 6. Product: Laykold Advantage Color.
- C. Line Paint
 - 1. Factory textured, wear-resistant acrylic emulsion line marking paint.
 - a. One coat hand painted or two coats if rolled.
 - b. Spray application not permitted.
 - 2. Percent solids by weight 67% minimum.
 - 3. Weight: 11.4 lbs/gal.
 - 4. Color: White.
 - 5. Product: Laykold Acrylic Paint.

2.3 CRACK & LEVELING BINDER PATCH REPAIR SYSTEM

- A. Three (3) coat acrylic color system existing courts with Rite-way Crack repair or approved equal. Products to be considered 'or equal' must be submitted and approved prior to the bid date. Products that develop humps or dead spots will not be acceptable.

2008 RiteWay Crack Repair, LLC

24 Spring St.

West Haven, CT 06516

Toll Free: 877-5-Riteway

Office: 203-745-0955

Fax: 203-285-3033

- B. Install as recommended compatible with color system by the manufacturer.

PART 3 EXECUTION

3.1 PREPARATION

- A. Follow manufacturer's preparation procedures.
- B. New asphalt substrates shall be allowed to cure a minimum of 30 days prior to application of any coatings.
- C. The substrate shall be clean and dry before coatings are applied. The surface of the substrate shall be inspected and free of grease, oil, dust, dirt and other foreign matter before any coatings are applied.

- D. Pressure wash entire court surface to remove all mildew, mold and debris using a rotating high pressure washing head capable of producing heated water. Utilize water reclamation and filtration systems to conserve water and reduce water runoff. Soiled water and debris must be contained and not allowed to run off into surrounding areas.
- E. Flood entire court surface with the Owner or Owner's representative present. After one hour of 70 degree sunny temperatures any depressions holding more than a nickel laying flat, will be defined and receive a shim of acrylic Leveling binder patch. Re-flood designated area to insure it is within tolerance. the finished surface shall have no depressions or ridges exceeding one eighth (1/8) inch in ten (10) feet. Clean and fill structural cracks with crack & leveling binder patch.

3.2 INSTALLATION

- A. Clean and fill structural cracks with crack repair/leveling binder patch system.
- B. Mix and apply acrylic resurfacer /filler per manufacturer's instructions. Court surfaces shall match existing colors.
 - 1. One coat on existing asphalt.
 - 2. Two coats on new asphalt.
 - a. Second coat shall be pulled 90 degrees to the first coat.
- C. Apply acrylic color finish in two coats per manufacturer's instructions. Courts shall be same color as filler coats.
 - 1. All color pigmented by the manufacturer. The use of neutral material pigmented on site will not be allowed.
 - 2. All acrylic color material must be mixed using a motor agitation system having a minimum capacity of 165 gallons.
 - 3. Color: Playing court and out of bounds area color to match existing, and to be approved by Owner.
 - 4. Mask and hand paint courts with acrylic white line paint two inches wide per USTA standards, accurately located and marked in accordance with rules of the high school tennis. No spraying of the line paint will be allowed.

END OF SECTION

SECTION 32 18 29
SYNTHETIC FIELD SPORT SURFACING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Drainage Base Layer, including subgrade preparation, subbase stone and drainage pipe.
- B. Synthetic Grass System for Athletic Field including carpet, shock pad, infill and markings.
- C. Equipment for Maintenance of Synthetic Turf Surface System.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill.
- D. Section 32 11 23 - Aggregate Base Courses.
- E. Section 32 33 45 - Athletic Field Equipment.
- F. Section 33 41 16.16 - Geocomposite Subdrainage.

1.3 REFERENCE STANDARDS

- A. ASTM D1335 - Standard Test Method for Tuft Bind of Pile Yarn Floor Coverings; 2021.
- B. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)); 2012 (Reapproved 2021).
- C. ASTM D2256/D2256M - Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method; 2021.
- D. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
- E. ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils; 1963 (Reapproved 2007).
- F. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.; 1999a (Reapproved 2014).
- G. ASTM D5823 - Standard Test Method for Tuft Height of Pile Floor Coverings; 2019.
- H. ASTM D5848 - Standard Test Method for Mass Per Unit Area of Pile Yarn Floor Coverings; 2010.
- I. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.
- J. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- K. ASTM F1936 - Standard Specification for Impact Attenuation of Turf Playing Systems as Measured in the Field; 2010 (Reapproved 2015).
- L. ASTM F2898 - Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method; 2011 (Reapproved 2019).

- M. NFHS (Guide) - Court and Field Diagram Guide; current edition.
- N. STC (GCRI) - Guidelines for Crumb Rubber Infill Used in Synthetic Turf Fields; 2010, Revised (2014).
- O. ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
- P. ASTM D1577 - Standard Test Method for Linear Density of Textile Fibers; 2007 (Reapproved 2018).
- Q. ASTM D5034 - Standard Test Method for Breaking Strength and Elongation of Textile fabrics (Grab Test).
- R. ASTM F1015 - Standard Test Method for Relative Abrasiveness of Synthetic Turf Playing Surfaces.
- S. ASTM F3188 - Standard Specification for Extractable Hazardous Metals in Synthetic Turf Infill Materials.
- T. Synthetic Turf Council - Suggested Guidelines for the Essential Elements of Synthetic Turf Systems

1.4 SUBMITTALS

- A. Within 72 hours of Bid Opening, as requested, the Contractor shall submit:
 - 1. Three (3) copies of a list of references from 10 similar exterior installations of the specified material with comparable square footage to this project in the last five years.
 - 2. Three (3) copies of the required prepaid insurance policy supported from a third party, A.M. Best, A-rated or better domestic insurance carrier.
 - 3. Three (3) copies of the Product Data, Detailed Specifications and Literature for the synthetic turf system and the individual components, including but not limited to the fiber, primary and secondary backing, rubber infill materials, and adhesives. Submittal shall include all properties, characteristics, and testing results listed in this specification.
 - 4. One (1) boxed 10 x 10 inches minimum sample of proposed synthetic turf system. Box must allow visibility of the proposed turf section.
 - 5. One (1) 18 x 18 inches minimum sample of the carpet with the fiber in place, without infill, including the primary and secondary backing.
 - 6. The Contractor shall provide in writing the names of three (3) existing clients for whom significant after-the-sale service work has been performed or for whom the Contractor has performed Warranty Services.
- B. Two (2) weeks prior to ordering of materials, the Contractor shall submit the following information below as a complete submittal. Because of the nature of the submittal, submittal review will not commence until all information is provided. All certifications, test results, shop drawings and other product information shall be checked and stamped as approved by the Contractor before submittal to the Architect.
 - 1. Samples:
 - a. One (1) boxed 10 x 10 inches min. sample of the proposed synthetic turf system - illustrating details of the complete and finished synthetic turf system product. including the infill materials as proposed to be installed. Box must allow visibility of the proposed turf section.
 - b. Two (2) - one quart samples of the sand infill material.
 - c. Two (2) - one quart samples of the rubber infill material.
 - d. Two (2) - 18 x 18 inches min. samples of the carpet with the fiber in place, without infill, including the primary and secondary backing.
 - e. Two (2) - 6 x 12 inches min. samples of all available fiber colors for game lines and markings for final selection by the Owner.
 - 2. Certifications, Five (5) copies each:
 - a. Documentation certifying that the Contractor has an additional prepaid insurance policy in place from a third-party "A"-rated domestic insurance carrier in accordance with the requirements specified in the Quality Assurance Section of this specification.
 - b. Sample Warranty: The Contractor and the Turf Manufacturer shall provide a sample copy of insured, non-prorated warranty and third-party insurance policy information which meets or exceed all of the warranty requirements defined in this specification.

SYNTHETIC FIELD SPORT SURFACING

- c. A signed letter from the Contractor and Turf Manufacturer that certifies:
 - 1) The products utilized for the synthetic turf system meet or exceed the specified requirements contained in this Specification and in the Contract Drawings. The letter shall include a written statement from the Turf Manufacturer detailing both the synthetic turf warranty period and the expected useful life of the turf.
 - 2) No lead or lead chromate components are utilized in the manufacturing of the turf system.
 - 3) The turf system complies with and meets the latest standards of the STC (GCRI) - Synthetic Turf Council guidelines and recommendations for installation and rubber infill materials.
 - 4) The turf system does not violate any other manufacturer's patents, patents allowed or patents pending.
 - 5) All of the required manufacturing and installation experience and training certification requirements specified in the Quality Assurance Section of this specification will be met.
3. Documentation of Experience:
 - a. Resume of Installation Supervisor who will be present on site throughout the duration of installation.
 - b. Resumes of Designated Installation Crew.
 - c. References for Contractor and Turf Manufacturer experience required in the Quality Assurance Section of this specification.
 - d. Certification by Turf Manufacturer of designated installation crew and Installation Supervisor.
4. Turf Laboratory Test Results: Five (5) Certified copies of independent (third-party) laboratory testing reports for the following tests:
 - a. Pile height, face width and total fabric weight - per ASTM D5848.
 - b. Primary and secondary backing weights - per ASTM D5848.
 - c. Tuft bind - per ASTM D1335.
 - d. Grab tear strength - per ASTM D5034.
 - e. Pill Burn test - per ASTM D2859.
5. Subbase and Chocker Stone Gradation Calculations and Laboratory Test Results, five (5) copies each:
 - a. All testing and gradation calculations shall be performed by a certified independent testing firm - retained and paid for by the aggregate supplier.
 - b. Gradation Test Results for aggregate materials defined in Section 2.1 Drainage Base Layer Materials of this specification.
 - c. Maximum dry density attainable through the Standard Proctor compaction test, ASTM D698.
6. Financial Statements; The Contractor and the Turf Manufacturer - at the Request of the Architect, shall provide a current audited company financial statement for each of the past three (3) years.
7. Five (5) copies of all Product Data, Detailed Specifications and Literature shall be submitted for the overall synthetic turf system and the individual components, including but not limited to the fiber, primary and secondary backing, rubber infill materials, drainage rate for complete installed system, adhesives, and the recommended field groomer. Submittal shall include all properties and characteristics listed in this specification. The Turf Manufacturer must submit the fiber manufacturer's name, type of fiber and composition of fiber.
8. Five (5) copies of Installation Procedures shall be submitted for the synthetic turf system and individual components.
9. Shop Drawings shall be submitted which include the following, five (5) copies each:
 - a. Field Layout
 - b. Field Marking Plans (in color), drawn to a scale of no greater than 1 inch = 30 feet with the required line and marking colors clearly shown, including all details and dimensions for all markings and their layout for the high school sports of Football, Soccer and Lacrosse. Provide individual plans for each sport and a composite plan that shows the lines and markings for all sports. Details shall be at a scale that provides a clear presentation.
 - c. Roll/Seaming Layout Plan.
 - d. Methods of attachment, field openings and perimeter conditions. Include all details for conditions where synthetic turf will be applied to covers, plugs, etc.

- C. Prior to installation of the shock pad, the General/Site Contractor shall submit a minimum of three (3) copies of the following:
 - 1. An As-Built Topographic Survey of the Prepared Finishing Stone Aggregate shall be performed and submitted per the requirements of Field Quality Control Section of this specification.
 - 2. A signed letter that that planarity checks have been performed on the Finishing stone aggregate layer in accordance with the requirements of Section 3.1 Examination of this specification.
- D. Prior to Final Acceptance, the Contractor shall submit a minimum of three (3) copies of the following:
 - 1. Field Maintenance Manuals, which will include all necessary instructions for the proper care and preventative maintenance for the synthetic turf system.
 - 2. Project Record Documents: Record actual locations of seams, anchors or other pertinent information.
 - 3. Warranty: Submit Manufacturer Warranty and ensure that forms have been completed in the Owner's name and registered with Manufacturer.

1.5 QUALITY ASSURANCE

- A. Provide a full-time on-site Installation Supervisor to review and coordinate the installation of the entire synthetic turf system, including subgrade preparation, and installation of the subbase and drainage system. Installation Supervisor must be present on-site through the duration of the installation.
- B. The Contractor shall meet the following criteria:
 - 1. Substantiate the ability to secure bonding capacity in excess of \$1,000,000 for this project.
 - 2. Demonstrate a track record where the Surety or Bonding Company has not been required to finish work.
 - 3. Demonstrate a financial strength to fully service and warrant the systems during the period of the warranty.
- C. Manufacturer/Installer's Experience:
 - 1. The Turf Manufacturer must be experienced in the manufacture and installation of this specific type of artificial turf system and provide references of this specific synthetic turf from 100 similar exterior installations, 15 of which must have occurred in the State of New York, of the specified material with comparable square footage to this project.
 - 2. The Contractor must have actively been in business, under its current name and ownership for at least the past five years; and must have a minimum of 25 sythentic turf fields in the United States that are currently in use and have been in use for at least five years.
 - 3. The Contractor must provide competent workmen skilled in this specific type of synthetic turf installation.
 - a. The designated Installation Supervisor on the project must be certified, in writing by the turf manufacturer, as competent in the installation of this material, including sewing, cutting, gluing, shearing seams, proper installation of the infill mixture and brushing operations. This supervisor must be certified by the distrubutor and have installed at least 25 synthetic turf systems of a similar size in the past 5 years.
 - b. The designated installation crew shall be certified in writing by the Turf Manufacturer and have installed at least 25 synthetic turf systems of a similar size in the past 5 years.
 - 4. The Contractor shall have a representative on-site to certify the installation and warranty compliance.
 - 5. The Contractor and/or Turf Manufacturer shall not have had a surety or bonding company finish work on any contract within the last 3 years.
 - 6. The Contractor and/or Turf Manufacturer shall never have been disqualified or barred from performing work from any public entity.

1.6 WARRANTY

- A. The Contractor and Turf Manufacturer shall provide a warranty to the Owner that includes the following in writing:

1. The turf warranty shall be from a single source, single policy and shall provide full coverage for all defects in all materials and workmanship of the synthetic turf system for its intended usability and playability for a period of ten (10) years from the date of Final Completion and acceptance of the turf field. The Turf Manufacturer must verify that their on-site representative has inspected the installation and that the work conforms to the manufacturer's requirements.
 2. In addition to the Contractor's/Manufacturer's single source warranty, an additional prepaid insurance policy supported from a third party, A.M. Best, A-rated or better domestic insurance carrier shall be provided. The insurance policy and manufacturer warranty shall be written specifically naming the field being constructed as part of this project and shall additionally require payment of a claim to be made directly to the Owner of said field. Evidence of such coverage must be submitted and approved.
 3. The turf warranty shall include general wear and damage caused from ultra-violet degradation.
 4. The turf warranty shall specifically list what components and properties are covered by the warranty. The list shall include but not be limited to any and all defects or failures relating to construction of the synthetic turf system, drainage through the synthetic turf system, synthetic turf seam rupture, synthetic turf yarn ultraviolet stability; excessive wear and tensile strength.
 5. The turf warranty shall cover defects in the workmanship of installation and further warrants that the installation was done in accordance with both the manufacturer's recommendations and any written directives of the manufacturer's on-site representative.
 6. The turf warranty shall include all necessary materials, labor, transportation costs, etc., to complete repairs or replacements. The warranty shall guarantee the availability of the same or better replacement materials for the synthetic turf system for the warranty period. The turf warranty must cover full replacement value of the total square footage installed including removal and disposal of failed turf system.
 7. The turf warranty shall be non-prorated and shall not place limits on the amount of field's usage.
 8. The turf warranty shall clearly define the conditions under which the manufacturer considers the warranty to be void.
 9. The turf warranty shall define the typical time frame within which repairs will be initiated by the synthetic Contractor, once notice has been received requesting repairs.
 10. The warranty shall guarantee the G-max ratings at the completion of construction and for the duration of the warranty as described in this specification.
- B. All designs, markings, layouts, and materials shall conform to all currently applicable National Federation State High School Association rules and other standards that may apply to this type of synthetic turf installation.
- C. All components and their installation method shall be designed and manufactured for use on outdoor athletic fields used for sports listed previously. The materials as hereinafter specified, should be able to withstand full climatic exposure in the State of New York; be resistant to insect infestation, rot, fungus and mildew; to ultra-violet light and heat degradation, and shall have the basic non clogging characteristic of flow through drainage allowing free movement of surface run-off through turf where such water may flow through the gravel blanket and into the field drainage system. The adhesive bonding and sewn seams of all system components shall provide a permanent, tight secure and hazard free athletic playing surface. All sheared and glued adhesive bonded and sewn seams shall, at a minimum, remain in place throughout the duration of the warranty period.

1.7 FIELD QUALITY CONTROL

- A. Aggregate Material Testing: The Contractor responsible for the installation of the stone base shall retain and pay for the services of an independent testing agency, subject to approval by the Owner, to provide the following testing services. If any tested material is found to be non-compliant with the requirements of the Contract Documents, the Contractor shall bear the cost of correcting the non-compliant condition, including if necessary, the removal of all non-compliant material from the project site and replacement of the materials to comply with the required specifications. All re-testing associated with noncompliant material shall be paid for by the Contractor.
1. In-Place Density Testing: Density testing shall be performed on the installed and prepared dynamic base stone in accordance with ASTM D6938. One density test will be performed per 2,500 SF of placed dynamic base stone.

2. The installed subbase shall drain at a rate of not less than 100 inches per hour.
 3. Gradation Testing: Gradation testing shall be performed on the dynamic base stone delivered to the project site in accordance with ASTM D422, Standard Test Method for Particle Size Analysis of Soils.
 4. Additional Testing: The Owner reserves the right to request that additional tests be performed that are deemed necessary to confirm that the installation of materials associated with the new synthetic turf playfield system comply with the requirements of tile Contract Documents.
- B. As-Built Survey: The Contractor installing the aggregate base shall provide an as-built survey of the final compacted finishing stone depicting the grades within the synthetic turf field area in half foot contours. The survey shall be performed and signed by a licensed Surveyor, Registered in the State of New York. The drawing shall be developed at a scale of 1 inch = 20 feet. The survey shall depict elevations in a grid pattern with maximum intervals between survey points of 20 feet in both directions, including elevations along the field crown line and perimeter boundary. Each survey point number and its corresponding elevation shall be shown on the as-built drawing using an established project bench mark. If any high and low spots are identified, adjustments shall be made by Contractor providing the aggregate base by adding or removing material to conform to the specified planarity and grades. Repair areas shall be re-graded and re-compacted to the specified tolerances prior to installing the finishing stone layer of the aggregate base course.
- C. Shock Attenuation Evaluation
1. G max Rating Requirements for Synthetic Turf System:
 - a. G max Rating Testing shall be performed in accordance with ASTM F1936.
 - b. Testing shall be paid for by the Contractor and performed by an Independent Testing Agency approved by the Owner.
 - c. G max Rating: No single test shall exceed 200g, and the average G max rating shall not exceed 165g.
 2. At the Substantial Completion of each Turf System, perform ten (10) in place G max tests at locations to be determined by the Owner and/or Architect. If any test results do not comply with the G max Rating Requirements specified, take corrective action as necessary to achieve satisfactory results. Perform additional testing to verify the results as directed by the Architect.
 3. During Warranty Period, the Owner reserves the right to have the field tested for shock attenuation at its own cost at any time it deems necessary. If at any time, the G-max Rating does not comply with the G-max Rating Requirements specified, it is the responsibility of the Contractor to take corrective action as necessary to achieve satisfactory results. If the G max rating the allowable limits after three attempts to repair the high rating, replace the field including disposal and removal of existing surface within 90 calendar days at no cost to the Owner.
- D. Infill Depth: Measurement of infill by Independent Testing Agency, approved by the Owner, to verify depth shall be taken at a minimum of ten (10) locations throughout each installed playfield. The amount of installed infill shall in all cases meet the minimum specified depth with an allowable tolerance of plus or minus ¼ inch.

1.8 MAINTENANCE

- A. The synthetic Contractor shall provide training for the Owner regarding the recommended maintenance program for the synthetic turf field. The training shall include a detailed review of the turf maintenance manual required to be provided by the synthetic turf manufacturer.
- B. Maintenance shall include site visit three months after installation and add/subtract infill material to account for typical break-in condition. Adjust Owners grooming equipment at time of installation and as necessary during the first three months of use to create optimum performance.
- C. Extra Materials: Upon final completion, provide the following materials directly to the Owner in the minimum quantities specified:
 1. Seaming Tape - 200 LF
 2. Seaming Epoxy - One standard sized pail.
 3. Turf fabric - 500 SF with at least one piece 15 feet wide by 10 feet long.
 4. 4 inch Wide Colored Fabric - Minimum 100 LF of each color specified for inlaid linestriping.

SYNTHETIC FIELD SPORT SURFACING

5. 2,000 pounds of ground rubber infill in weatherproof containers.

PART 2 PRODUCTS

2.1 DRAINAGE BASE LAYER MATERIALS

- A. Geotextile Filter Fabric: Non-woven polypropylene geotextile fabric. Mirafi 140N or approved equal as shown on drawings.
- B. Geotextile Stabilization Fabric: Woven polypropylene geotextile fabric. Mirafi 500X or approved equal as shown on drawings.
- C. Drainage Pipe: See Section 33 41 16.16 - Geocomposite Subdrainage.
- D. Base Stone Aggregate Material: AASHTO #57 clean washed stone at a minimum depth of five (5) inches or per Turf Manufacturer recommendations.

Sieve	Approximate Percent Passing
1-1/2"	100%
1"	95-100%
1/2"	25-60%
#4	0-10%
#8	0-5%

- E. Finishing Stone Aggregate Material: Crushed limestone blend, clean washed stone at a minimum depth of one (1) inch or per Turf Manufacturer recommendations.

Sieve	Approximate Percent Passing
1/2"	100%
3/8"	95-100%
#4	70-85%
#8	45-60%
#16	25-40%
#100	8-15%
#200	0-5%

2.2 SYNTHETIC GRASS SYSTEM

- A. Manufacturers
1. A-Turf: www.aturf.com.
 2. FieldTurf: www.fieldturf.com.
 3. AstroTurf: www.astroturf.com.
- B. General Carpet Requirements:
1. Shall have the characteristics of a flow-through drainage system allowing free movement of surface run-off through the turf and directly into the prepared aggregate base and into the field drainage system. The system and all components shall be non-toxic with respect to the users and the environment including no intentionally added PFAS.
 2. Face Yarn Type: 100% U.V. resistant polyethylene blended multifilament system consisting of rigid monofilament strands and parallel-long slit film fibers.
 3. Primary Backing: Double layered polypropylene porous fabric treated with U.V. inhibitors.
 4. Secondary Backing: Porous, heat activated urethane to permanently lock fiber tufts in place.
 5. Color: As shown on drawings and approved by Owner.
 6. Construction: Broadloom tufted.
 7. Furnished in 15' wide rolls.
 8. Turf panels including inlaid markings, must be sewn, glued panel seams are not acceptable.
 9. All markings are to be factory tufted or inlaid at the project site. No line painting will be allowed.

SYNTHETIC FIELD SPORT SURFACING

- C. Minimum Carpet Properties:
 - 1. Minimum Yarn Linear Density: minimum 5,000 denier for slit-film fibers and minimum 7,200 denier for rigid monofilament. (ASTM D1577)
 - 2. Minimum Yarn Thickness: 100 microns for slit-film fibers and 240 microns for rigid monofilament.
 - 3. Minimum Yarn Breaking Strength: 20 lbs. nominal. ASTM D2256/D2256M
 - 4. Pile Height: 2 inches nominal. ASTM D5823
 - 5. Minimum Pile Weight - 52 oz/sy minimum. ASTM D5848
 - 6. Minimum Primary Backing Weight - 7.0 oz/sy minimum. ASTM D5848
 - 7. Minimum Secondary Backing Weight - 16 - 22 oz/sy. ASTM D5848
 - 8. Minimum Total Product Weight: 75 oz/sy. ASTM D5848
 - 9. Minimum Tuft Bind: 8 lbs/force without infill. ASTM D1335
 - 10. Minimum Grab Tear (width): >200 lbs/force (ASTM D5034)
 - 11. Minimum Grab Tear (length): >200 lbs/force (ASTM D5034)
 - 12. Minimum Permeability: 30 inches/hour. (ASTM D4491)
 - 13. Flammability (Pill Burn): Pass ASTM D2859
 - 14. Maximum Yarn Elongation: 50% nominal.
- D. General Resilient Infill Requirements:
 - 1. Controlled resilient layered granular mixture, partially covering carpet, consisting of graded clean silica sand and processed rubber crumb.
 - 2. Minimum Weight: 6 lbs per square foot.
 - 3. Infill Depth: 1.75 inches deep minimum.
 - 4. Infill Sand: Specifically-graded dust-free silica sand. The sand shall be delivered to the site graded, washed and dried. The sand particles shall be rounded to sub-angular so as to minimize abrasion to the athlete and synthetic turf fibers.
 - 5. Infill Rubber: Ambiently processed, hammer-milled clean, dust-free, contaminant free and metal-free SBR rubber crumb. The SBR particles shall be processed and sized under rigid specifications and in accordance with the Turf Manufacturer's quality control program.
 - 6. Infill materials must meet or exceed ASTM F3188 requirements.
 - 7. Infill material to be supplied by an SBR crumb rubber manufacturer.
- E. Accessories: Glue, thread, paint, seaming fabric and other materials used to install and mark the synthetic turf surfacing system shall be provided as recommended by the Turf Manufacturer.
- F. Nailer: Pressure Treated wood nailer provided at all edges as shown on drawings and detail. See unit pricing.

PART 3 EXECUTION

3.1 PRE-CONSTRUCTION MEETINGS:

- A. An interview shall take place at a time and date to be determined by the Architect. Present at this meeting shall be the Architect, Landscape Architect, Owner's Representative(s), the Project Manager and Site Superintendent for the Prime Contractor and the Project Manager and Project Foreman for the Contractor. The purpose of this meeting will be to review turf product and installation means and methods, to interview and ascertain the experience and competence of the Turf Manufacturer, as well as, the on-site Project Foreman for this project and to review the project schedule. Contractor shall submit all required submittals, warranties and insurance at or before this meeting.
- B. A second meeting shall take place at a time and date to be determined by the Architect. Present at this meeting shall be the Architect, Landscape Architect, Owner's Representative(s), and the Project Manager for the Site Contractor. The purpose of this meeting shall be to review and confirm schedule. (with particular attention on the turf installation) and to confirm that the turf product has been ordered by way of notarized copies of the original confirmed Purchase Order and guaranteed delivery date.

3.2 GENERAL REQUIREMENTS

- A. The Contractor shall strictly adhere to the installation procedures outlined under this and following sections. Any variance from these requirements must be accepted in writing, by the Contractor and Turf Manufacturer, and submitted to the Architect/Owner, verifying that the changes do not in any way affect the warranty.
- B. Do not install synthetic turf system when ambient temperature is below 45 degrees F, above 110 degrees F, if materials are wet, or if rain is falling or pending. Materials can be installed under dry conditions only.
- C. Notify the Architect when each major component is near completion for review prior to proceeding to next operation.

3.3 PREPARATION

- A. Excavation: Site Contractor shall excavate natural grass field, topsoil, and subsoil as necessary to meet the subgrade elevations and established in the Contract Documents plans and details. See 31 23 16 - Excavation for related requirements.
- B. Refer to 31 22 00 - Grading, and 31 23 23 - Fill for related requirements.
- C. The subgrade shall be sloped at a minimum of 0.5% to mirror final field grades, unless otherwise directed in the plans and details. Subgrade is to be sloped toward the drainage piping at the perimeter of the field.
- D. Subgrade shall be proof rolled and compacted to a minimum of a 90% compaction rate. Notify Architect if soils not able to achieve the proper compaction. Areas which cannot achieve the proper compaction shall be over-excavated and structural fill shall be installed, recompacted, and retested.
- E. Excess and unsuitable soils shall be removed from the project site.
- F. Site Contractor shall install all conduit and other utility piping in accordance with the plans, details, and appropriate specifications, including required backfilling, compaction and testing.

3.4 DRAINAGE BASE LAYER INSTALLATION

- A. Install geotextile fabric over excavated and prepared subgrade. Provide a 36 inch minimum overlap at all seams. The entire field shall be covered with fabric prior to the base aggregate application.
- B. Install lateral subdrainage pipes on geotextile fabric as shown on the plans and connect to perimeter drain pipes.
- C. Base Stone: The installation of the base stone shall only begin after the drainage pipe installation has been inspected and approved by the Architect. Installation of the Free Draining Base Stone shall follow procedures that protect the subgrade soils and drainage pipe. The drainage pipe network and its existing elevations shall not be disrupted through ground pressures from trucks, dozers or by any other means.
 - 1. The subgrade shall be dry before undertaking the placement of base stone.
 - 2. Delivery trucks shall enter the field only from the designated entrance point. Base stone shall be dumped closest to the entrance first and continuously worked towards the furthest point of the field. Extreme care must be taken not to disturb subgrade or drainage network.
 - 3. Track-type dozers shall push out the stone from behind the pile onto and toward the field center. Dozers shall only traffic the aggregate they are spreading.
 - 4. Bulldozer blades shall be equipped with a laser-guided hydraulic system. Care shall be taken not to disturb or contact the subgrade soils with the dozer blades or tracks. All equipment trafficking over the drainage aggregate shall insure there is a minimum depth of 4 inches of aggregate between the geotextile fabric and the dozer track ground contact position.
 - 5. When the stone spreading is completed, the surface shall be further-firmed by a 5-ton roller. Static vibration shall not be part of this process.
 - 6. The stone shall be left firm, but not over-compacted as to protect the porosity and drainage capabilities of the aggregate profile.

7. After the base stone has been uniformly spread throughout the surface, the surface shall receive a final laser finished grade. This process shall be accomplished using a turf-type tractor, or lightweight grader, equipped with high flotation tires and a hydraulically controlled laser blade.
 8. Verify the compaction of the base stone course is 95% according to the Modified Proctor procedure ASTM D1557, and that the surface tolerance does not exceed ¼ inch over 10 feet and ½ inch from design grade. The synthetic Contractor shall provide a minimum of 48 hours notice to the Owner and the Architect prior to scheduling final compaction or planarity testing.
- D. Finishing Stone Aggregate: The installation of the finishing stone shall only begin after the base stone has been inspected and approved by the Architect.
1. The finishing stone layer shall be applied using laser-controlled low ground pressure grading equipment.
 2. Arrange for the inspection of the Finishing Stone and curbs using a laser level and plot on a 10 foot topographical grid. Based on this topographical survey, arrange for the suitable fine grading of the Finishing Stone area, including proper rolling and compacting.
 3. Final layer of stone must be installed at a depth as indicated on drawings. Finished aggregate base must be proof-rolled by means of 2- to 5-ton roller. It shall also be flush with top of nailer.
 4. Notify the Architect prior to the commencement of fine grading, for a visual inspection of Finishing Stone condition. If contamination or disturbance of the Base Stone is evident, remove finishing stone as directed by Architect for inspection and testing of Base Stone.
 5. Provide grading and compaction to the lines, grades, slopes and typical sections indicated on the Contract Drawings. Compact the finishing stone within the range of 90% dry density attainable through the Standard Proctor compaction test ASTM D698. It is necessary to maintain the compaction within this range to provide stability also to maintain the permeability characteristics of the prepared material. Take precautions and use the appropriate equipment to avoid over-compaction of the finishing stone aggregate. Perform compaction operations in both directions.
 6. Planarity tolerance for the completed finishing stone aggregate installation is ¼ inch over 10 feet from any given point in any direction, as measured with a 10- foot long straightedge. Finished grade of the prepared finishing stone shall not deviate by more than 1/8 -inch from the extrapolated design grade. This tolerance is required over the entire field.
 7. A planarity check letter shall be performed and a certification shall be submitted by the Contractor.
 8. Additionally, an as-built survey in accordance with this specification shall be performed.
 9. Arrange for Turf Manufacturer to inspect and certify that the finishing stone area to receive the synthetic turf surfacing is ready for installation of the underlayment shock pad; is perfectly clean as the installation commences; and will be maintained in that condition throughout the installation process.
 10. Stone base installing Contractor to preform field permeability testing according to ASTM F2898 - Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method. Results to be submitted to Architect for approval prior to proceeding.
 - a. Minimum allowable permeability rates:
 - 1) New fields: 16 inches per hour.
 - 2) Existing fields being recovered: 10 inches per hour.
 11. When the Contractor confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.5 SYNTHETIC GRASS CARPET INSTALLATION

- A. The rolls of turf shall be rolled out a minimum of four hours prior to starting seaming procedures and allowed to relax/expand.
1. All visible wrinkles shall be stretched out before seaming.
 2. Seams shall be flat, tight and permanent with no separation or fraying.

3. Synthetic turf yarn fabric that is trapped or glued between seams shall be freed from the seams by hand or other approved method to an upright position prior to the commencement of brushing and top dressing procedures.
- B. Lay full width rolls across the field of sufficient length to permit full cross field installation from sideline to sideline without head or cross seams in the main playing area between sidelines. The first roll shall begin with the longest perpendicular cross-field distance.
- C. Provide 99% sewn installation. Minimal gluing will be permitted to repair problem areas, corner completions, and to cut in any logos or Inlaid lines as required. All seams shall be sewn using double bagger stitches and polyester thread or adhered using seaming tape and high grade adhesive per the manufacturer's standard procedures. Make all seams flat, tight and permanent without separation or fraying.
- D. GLUING OF ROLLS SHALL NOT BE ACCEPTABLE.
- E. When all rolls of the playing surface have been attached, install sideline areas at right angles to the playing field synthetic turf area.
- F. Install synthetic turf for the covers of the power/communication boxes, plugs for the drainage system clean outs, filler plug covers for the football goal posts and any other "in-ground" components within the limits of the synthetic turf field.
- G. Attach the synthetic turf surfacing to the perimeter edge as detailed on the Contract Documents and in strict accordance with the Turf Manufacturer's standard recommendations.

3.6 FIELD MARKINGS

- A. Standards:
 1. All designs, markings, layouts, field lines and materials for indicated sports previous in accordance with the current National Federation of State High School Associations NFHS (Guide) "Rules Book" for each sport.
 2. All lines and markings for the sports indicated previously.
 3. All preliminary colors of field lines and markings are included in the Contract Documents. Final color selection will be made by the Owner.
- B. For the purpose of developing the Contract Bid Price, the Contractor shall assume that all field lines are independent of each other and that no common field lines will be permitted. In all instances where field lines for different sports are defined to be in the same location the lines shall be tufted or inlaid directly adjacent to each other. Installation of common sport field lines will be considered as part of a playfield linestripping shop drawing provided by the contractor during the submittal process.
- C. If NFHS (Guide) rules provide a range of acceptable line widths, the contractor shall include the cost to provide the widest for the bid price, unless specifically indicated otherwise on the Contract Documents. The final determination of line widths shall be made during the review of submittals.
- D. Inlaid lines, markings, and logos are to be installed by shearing and gluing and in accordance with the requirements of the Turf Manufacturer. The primary and secondary backing are not to be cut when installing inlaid lines.
- E. At completion of the carpet and markings installation, notify Architect for review three (3) days before proceeding with installation of subsequent component.

3.7 INFILL MATERIAL INSTALLATION

- A. Apply infill materials in numerous thin lifts. Install infill to a 1 3/4 inch depth at the weight specified for the manufacturer minimum 6 lbs per sq ft 3 lbs sand and 3 lbs rubber. Place infill with a 1/2 inch void to the top of the fibers.

- B. Install Infill materials to fill voids between the fibers and to allow the fibers to remain vertical and non-directional.
- C. Between applications, the infill area shall be brushed with a motorized rotary nylon broom.
- D. Install infill to a 1.75 inch depth at the weight specified by the Turf Manufacturer. Place infill with a 1/2 inch void to the top of the fibers.
- E. The Contractor shall have the depth of infill confirmed in accordance with the testing requirements specified herein. Results shall be provided to the Architect.
- F. The Contractor shall re-visit site three months after installation and add/subtract infill material to account for typical break-in condition. Adjust grooming equipment at time of installation and as necessary during the first three months of use to create optimum performance.
- G. At substantial completion, the Contractor shall notify the Architect for final inspection and review. The Shock Attenuation Evaluation specified herein shall be scheduled after final inspection has been completed and punch list items addressed.

3.8 CLOSEOUT

- A. The Contractor and Turf Manufacturer must verify that their on-site representative has inspected the installation and that the work conforms to the manufacturer's requirements.
- B. The Contractor shall provide Shock Attenuation Evaluation in accordance with this specification, and certify that it meets the specified G-max criteria.
- C. The Contractor and Turf Manufacturer shall provide the submittals required, including any required warranty, maintenance manuals, and as-built striping layout.

3.9 CLEAN UP

- A. Contractor shall provide the labor, supplies and equipment as necessary for final cleaning of surfaces and installed items.
- B. All usable remnants of new material shall be neatly rolled up and turned over to the Owner, if desired, at a place and area designated by the Owner.
- C. During the contract and at intervals as directed by the Architect and as synthetic turf installation is completed, clear the site of all extraneous materials, rubbish, or debris and leave the site in a clean, safe, well draining, neat condition.
- D. Surfaces, recesses, enclosures, etc., shall be cleaned as necessary to leave the work area in a clean, immaculate condition ready for immediate occupancy and use by the Owner.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Posts, rails, and frames.
- B. Wire fabric.
- C. Concrete.
- D. Manual gates with related hardware.
- E. Accessories.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete anchorage for posts.

1.3 REFERENCE STANDARDS

- A. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire; 2022.
- B. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- C. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- D. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric; 2011a (Reapproved 2022).
- E. ASTM A428/A428M - Standard Test Method for Weight [Mass] of Coating on Aluminum-Coated Iron or Steel Articles; 2021.
- F. ASTM A491 - Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric; 2011 (Reapproved 2022).
- G. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- H. 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; 2023.
- I. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
- J. ASTM F567 - Standard Practice for Installation of Chain-Link Fence; 2023.
- K. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework; 2018 (Reapproved 2022).
- L. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures; 2018 (Reapproved 2022).
- M. CLFMI CLF-FIG0111 - Field Inspection Guide; 2014.

- N. CLFMI CLF-PM0610 - Product Manual; 2017.
- O. CLFMI CLF-SFR0111 - Security Fencing Recommendations; 2014.
- P. FS RR-F-191/1D - Fencing, Wire and Post Metal (Chain-Link Fence Fabric); 1990.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fabric, posts, accessories, fittings and hardware.
- C. 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.
- D. Manufacturer's Installation Instructions: Indicate installation requirements, post foundation anchor bolt templates, and shop drawings.
- E. Manufacturer's Qualification Statement.
- F. Fence Installer Qualification Statement.
- G. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines.

1.5 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.

1.6 WARRANTY

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Chain Link Fences and Gates:
 - 1. Master-Halco, Inc.: www.masterhalco.com.
 - 2. Merchants Metals: www.merchantsmetals.com.
 - 3. Wheatland Tube Company: www.wheatland.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 COMPONENTS

- A. Line Posts:
 - 1. Up to 6 feet high: 1.9 inch O.D.
 - 2. Up to 8 feet high: 2.375 inch O.D.
- B. Corner and Terminal Posts:
 - 1. Up to 6 feet high: 2.375 inch O.D.
 - 2. Up to 8 feet high: 2.88 inch O.D.

C. Gate Posts:

Gate Fabric Height Up To & Including 6 ft Gate Fabric Height Over 6 ft To 12 ft			
Gate Leaf Width	Outside Diameter	Gate Leaf Width	Outside Diameter
up to 4 ft	2.375 in	up to 6 ft	2.875 in
over 4 ft to 10 ft	2.875 in	over 6 ft to 12 ft	4.000 in
over 10 ft to 18 ft	4.000 in	over 12 ft to 18 ft	6.625 in
		over 18 ft to 24 ft	8.625 in

- D. Top and Brace Rail: 1.66 inch diameter, plain end, sleeve coupled.
- E. Bottom Rail: 1.66 inch diameter, plain end, sleeve coupled.
- F. Gate Frame: 1.66 inch diameter for welded fabrication.
- G. Fabric: 2 inch diamond mesh interwoven wire, 9 gauge, 0.1483 inch thick, top selvage knuckle end closed, bottom selvage knuckle end closed or equivalent.
- H. Tension Wire: 7 gauge, .177 inch thick steel, single strand.
- I. Tension Band: 3/16 x 3/4 inch thick, minimum cast steel, galvanized.
- J. Tension Strap: 196 inch thick, minimum cast steel, galvanized.
- K. Tie Wire: 9 gauge aluminum core; vinyl coated to 6 gauge.

2.3 MATERIALS

A. Posts, Rails, and Frames:

1. Formed from hot-dipped galvanized steel sheet, ASTM A653/A653M, HSLAS, Grade 50, with G90 (Z275) zinc coating.
2. Line Posts: Type I round in accordance with FS RR-F-191/1D.
3. Terminal, Corner, Rail, Brace, and Gate Posts: Type I round in accordance with FS RR-F-191/1D.

B. Wire Fabric Vinyl Coated:

1. ASTM A392 zinc coated steel chain link fabric.
2. Comply with CLFMI CLF-PM0610.
3. Where wire gauge is indicated for fabric, the gauge shall refer to the wire (core) prior to vinyl coating.

C. Concrete:

1. Type specified in Section 03 30 00.

2.4 MANUAL GATES AND RELATED HARDWARE

- A. Hardware for Single Swinging Gates: 180 degree box hinges, 2 for gates up to 60 inches high, 3 for taller gates; strong arm latch.
- B. Hardware for Double Swinging Gates: 180 degree box hinges, 2 for gates up to 60 inches high, 3 for taller gates; strong arm latch.
- C. Hardware for Double Swinging Vehicle Gates: 180 degree box hinges, 2 for gates up to 60 inches high, 3 for taller gates; strong arm latch, drop bolt on inactive leaf engaging socket stop set in concrete, active leaf latched to inactive leaf preventing raising of drop bolt, padlock hasp.
- D. Hinges: Finished to match fence components.
 1. Brackets: Round.
 2. Mounting: Center.
 3. Closing: Manual.

- E. Latches: Finished to match fence components.
 - 1. Locking: Mechanical.

2.5 ACCESSORIES

- A. Caps: Cast steel galvanized; Vinyl coated sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; Cast Steel Galvanized.

2.6 FINISHES

- A. Hardware: Hot-dip galvanized to weight required by ASTM A153/A153M.
- B. Accessories: Same finish as framing.
- C. Color(s): To be selected by Architect from manufacturer's standard range.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that areas are clear of obstructions or debris.

3.2 PREPARATION

- A. Removal: Obstructions or debris.

3.3 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate posts plumb, in concrete footings with top of footing 3 inches below finish grade. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: ASTM F 567.
- E. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: ASTM F 567.
- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. 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. Install center brace rail on corner gate leaves.
- I. Do not stretch fabric until concrete foundation has cured 7 days.
- J. Stretch fabric between terminal posts or at intervals of 500 foot maximum, whichever is less.
- K. Position bottom of fabric 2 inches above finished grade.
- L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- N. Install bottom tension wire stretched taut between terminal posts.
- O. Do not attach the hinged side of gate to building wall; provide gate posts.

- P. Install hardware and gate with fabric to match fence.
- Q. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.

3.4 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.

3.5 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - 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 three 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.

3.6 CLEANING

- A. Leave immediate work area neat at end of each work day.
- B. Clean jobsite of excess materials; scatter excess material from post hole excavations uniformly away from posts. Remove excess material if required.
- C. Clean fence with mild household detergent and clean water rinse well.
- D. 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.
- E. Touch up scratched surfaces using materials recommended by manufacturer. Match touched-up paint color to factory-applied finish.

3.7 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - 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. Location: At project site.

END OF SECTION

SECTION 32 33 45
ATHLETIC FIELD EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Baseball Equipment.
- B. Softball Equipment.
- C. Ball Safety Netting.
- D. Enclosed Dugouts.

1.2 RELATED REQUIREMENTS

- A. Section 01 30 00 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.
- B. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.

1.3 REFERENCE STANDARDS

- A. ASCE 7-10 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures; 2010.
- B. NFHS (Guide) - Court and Field Diagram Guide; current edition.
- C. NYSPHSAA - New York State Public High School Athletic Association.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturers product data prior to actual field installation work, for Architect's or Owner's representatives review.
- C. Shop Drawings: Provide drawings of the manufacturers recommended installation and foundation requirements prior to actual field installation work, for Architect's or Owner's representatives review.
- D. Shop Drawings and Calculations: Manufacturer shall design foundations and reinforcement for Tension Batting Tunnels and Ball Safety Tension Netting Systems under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State of New York. Foundation design drawings and calculations shall be signed and sealed by the Delegated Design Professional.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.
- F. Manufacturer's Installation Instructions: Indicate special considerations or requirements for proper installation.
- G. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
- H. Specimen Warranty.
- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project:
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with minimum three years of documented experience.
- C. Installer Qualifications for Ball Safety Netting System & Dugouts: Installer shall have a minimum three years of documented experience and a minimum of five system/dugout installations or similar experience.

1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. The Contractor shall furnish a warranty that the equipment and all parts thereof shall be first class and free from defects and the manufacturer will, upon notice and without undue delay, without expense to Owner, make good or repair the whole or any part of the equipment furnished by him which shall, within two years from the date of acceptance of the completed work, fail or develop unfitness for the purpose which is intended, as a result of any defect in design, material or workmanship.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Douglas Sports Equipment; 800-553-8907: www.douglas-sports.com.
- B. Sportsfield Specialties Inc; 888-975-3343: www.sportsfield.com.
- C. Or Approved Equal.
- D. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 BASEBALL EQUIPMENT

- A. Pitching Mound - Single Bullpen (For Batting Tunnels):
 - 1. Model PMFSBPS by Sportsfield Specialties, Inc.
 - a. Or Approved Equal.
 - 2. Welded construction, fabricated of 1/8 inch aluminum sheet structure.
 - 3. Knock out perforations for concrete flow in multi-mound systems.
 - 4. Center section height of 10 inches above finish grade and sloped 1 inch vertical per 1 foot horizontal per specifications, rules and requirements.
 - 5. Three piece welded form sections with bolted connections.
 - 6. Notched cutouts for rebar bracing and stake holes for rebar anchoring (Rebar by Others).
 - 7. Center Section Includes Two 1/2 inch Sch. 40 Aluminum Drainage Pipes and Removable Pitching Rubber Tray with four 3/4 inch Aluminum Round Stock Threaded Studs with 3/8" Stainless Steel Bolts for Pitching Rubber Height Adjustment.
 - 8. Includes replaceable SHBBPB Schutt four-sided professional pitching rubber.
 - 9. Includes synthetic infill turf attachment ledge.
 - 10. Includes 1/4 inch roll out rubber underlayment for high traffic areas.
 - 11. Synthetic turf replacement center section: Sized 58 inch W x 152 inch L.
- B. Bases
 - 1. Natural Turf - Semi-Permanent Bases:
 - a. Models indicated by SportsField Specialties, Inc.
 - 1) Or Approved Equal.

- b. Schutt Hollywood Impact Bases Model SHILB for turf applications with ground mount Model SHAFIT.
- c. Home plate forming system Model SHAFIT:
 - 1) Measures 32 inches L x 32 inches W x 5 inches H.
 - 2) Welded construction, fabricated of 1/8 inch aluminum sheet with one 1/2 inch Sch. 40 aluminum drainage pipe and five 3/4 inch aluminum round stock threaded studs with 3/8 inch stainless steel bolts for home plate tray height adjustment.
 - 3) Removable and height adjustable home plate tray, fabricated of 1/8 inch aluminum sheet.
 - 4) Includes replaceable SHSRHP Schutt hollywood bury all home plate.
 - 5) Includes synthetic infill turf attachment ledge.
 - 6) Optional:
 - (a) Model HPFSCP Removable cover plug: 1/8 inch aluminum sheet with 1.5 inch square aluminum support structure, synthetic turf provided by others.
- 2. All rubber construction with mesh reinforcement comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - a. National Federation of State High School Associations (NFHS).
 - b. National Collegiate Athletic Association (NCAA).
 - c. International Association of Athletics Federations (IAAF).
 - d. American Sports Builders Association (ASBA).
 - e. Manufacturers Data and Recommended Installation Requirements.

2.3 SOFTBALL EQUIPMENT

A. Bases

- 1. Natural Turf - Models indicated below by SportsField Specialties, Inc.
 - a. Model SHSRHP Bury-All - Home plate for natural turf, with stanchions.
 - 1) Provide matching ground anchor mounts and base plugs.
 - b. Model SHLBMPR224- Pitching rubber for natural turf.
 - 1) Provide ground anchors.
 - c. Or Approved Equal.
- 2. All rubber construction with mesh reinforcement comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
 - a. National Federation of State High School Associations (NFHS).
 - b. National Collegiate Athletic Association (NCAA).
 - c. International Association of Athletics Federations (IAAF).
 - d. American Sports Builders Association (ASBA).
 - e. Manufacturers Data and Recommended Installation Requirements.

2.4 OUTDOOR BATTING TUNNEL

A. Manufacturers:

- 1. Sportsfield Specialties; BTTBS Single tension baseball batting tunnel: www.sportsfield.com.
- 2. Or Approved Equal.
- 3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Tension Cable Style Batting Tunnel:

- 1. Upright Poles: 8 inch Schedule 40 Steel (8.625 inch O.D.) Pipe.
- 2. Extension Arms: 3/8 inch Steel Plate x 18 inch Long.
- 3. Crossbar Supports: 4 inch x 3/16 inch wall Square Steel Tube.
- 4. UV resistant Black Powder Coated Finish.
- 5. Tension Cable Support: 1/4 inch 7x19 Black Powder Coated Galvanized Aircraft Cable with 1/2 inch x 6 inch Jaw and Jaw Turnbuckles.
- 6. Netting: No. 36 by 1-3/4 inch square mesh netting, with rope bound perimeter.
 - a. Color: Black.

- b. Entryways: 4 foot Wide x Full Height; Overlapped.
- c. Black Vinyl Encased ¼ inch Galvanized Chain Ground Weight.
- 7. Provide hardware and accessories as required for complete assembly.

2.5 BALL SAFETY EQUIPMENT

- A. Pole-to-Pole Ball Safety Netting System and Accessories:
 - 1. TNPPUC Pole-to-Pole Ball Safety Netting System with Ultra Cross Netting and Accessories by Sportsfield Specialties, Inc.
 - a. Or Approved Equal.
 - 2. Components:
 - a. Pole-to-Pole Tension Ball Safety Netting System Upright Support Posts and Pole Structures - Fabricated, Sized, and Configured as Required:
 - 1) Height Above Finish Grade as Required
 - 2) Two (2) Coat Powder Coated Process Consisting of Zinc Gray Epoxy Primer and Super Durable Black Finish with Enhanced Resistance to UV and Fade
 - 3) Ground Sleeve, Base Plate or Permanent Embedment Mount
 - 4) Hot Dipped Galvanized Assembly Hardware - Quantities, Sizes and Configurations as Required
 - b. Pole-to-Pole Tension Ball Safety Netting System Wire Rope Support Structure:
 - 1) Length, Height and Configuration as Required
 - 2) 7 x 19 GAC Galvanized Aircraft Cable - 5/16" Diameter Main Horizontal Support, 9,800 lb. Minimum Braeaking Strength, 3,267 lb. Minimum Working Load Limit
 - 3) Hot Dipped Galvanized Attachment and Assembly Hardware - Quantities, Sizes and Configurations as Required
 - c. Pole-to-Pole Tension Ball Safety Netting System Net and Rope Bound Border:
 - 1) Length, Height, and Configuration as Required
 - 2) Ultra Cross Knotless Netting
 - 3) Dyneema® Ultra-High Molecular Weight Polyethylene (UHMWPE) SK-75 Black Fiber Construction
 - 4) 4 Ply, 1.2 mm (0.0472") Diameter Twine
 - 5) 95% Open Mesh Area (See-Through Visibility)
 - 6) 58,445 psi Minimum Breaking Strength
 - 7) 30% Maximum Elongation at Break
 - 8) 1-3/4" (44 mm) Square Mesh Size, 0.009 lbs. per Square Foot
 - 9) 4-Strand, Braided, Continuous Monofilament Dyneema® Fiber
 - 10) Black Multi-Filament Polypropylene Solid Braid Derby Rope Sewn Binding on Perimete Edges - 1/4" Diameter, 530 lb. Minimum Breaking Strength
 - 11) Urethane Black Bonded Finish
 - 12) Strong Resistance to Ultraviolet (UV) Light Degradation
 - 13) Excellent Resistance to Chemicals and Water Absorption
 - d. Included Accessories:
 - 1) Hot Dipped Galvanized Attachment and Assembly Hardware - Quantities, Sizes and Configurations as Required
 - 2) Black Rope for Net Binding Attachment to Wire Rope Support Structure - Quantities and Configurations as Required
 - 3) Stamped and SEaled Drawings and Calculations by a Licensed Professional Engineer of Record in the State of Project Location
 - 4) Model Specific Hardware Kit and Installation Instructions
 - 5) One (1) Year Limited Manufacturer's Product Warranty

2.6 ENCLOSED DUGOUT 8'W X 40'L

- A. Basis of Design: ED8X40 - Enclosed Dugout 8'W x 40'L as Manufactured and Supplied by:
 - 1. Sportsfield Specialties, Inc.
 - 2. Or Approved Equal

- B. Design Criteria:
 - 1. Building Code: ASCE 7-10
 - 2. Maximum Wind Speed Rating: 140mph, Exposure Category C
 - 3. Maximum Ground Snow Load: 60psf
 - 4. Seismic Design: Category E, $S_s=1.5g$, $S_1=0.75g$
 - 5. Roof Pitch: 2" Rise Back-to-Front
- C. Components:
 - 1. Enclosed Dugout:
 - a. Overall Dimensions: 8'-1"W x 40'L
 - b. Wall Frames Fabricated of:
 - 1) 3-1/2" x 3-1/2" x 3/16" (0.1875") Structural Steel Tube, Fully Welded Construction
 - 2) Vertical Columns Include Factory Pre-Drilled 8-1/4" x 8" x 5/8" (0.625") A36 Steel Base Mounting Plates
 - (a) Maximum Allowable Spacing Between Rear Columns is Eight Feet (8') On-Center
 - (b) Maximum Allowable Spacing Between Front Columns is (16') On-Center (In Wall)
 - 3) 18 Gauge Galvanized Steel Track and Studs, 16" On-Center (In Wall)
 - c. Roof Frame Fabricated of:
 - 1) 3-1/2" x 3-1/2" x 3/16" (0.1875") Structural Steel Perimeter and Transverse Roof Tubes, and 3" x 2" x 11 Gauge Structural Steel Longitudinal Roof Tubes
 - 2) Fully Welded Construction
 - d. Structural Steel Wall and Roof Frame Receives a Powder Coated Primer and Coated Finish, Various Standard and Custom Colors Available. Color to be confirmed with Owner prior to purchase.
 - e. Roofing Material is 29 Gauge, Classic Rib® Style Corrugated Metal with J-Channel Drip Cap Installed on Front and Sides, Various Standard Paint Finish Colors Available
 - f. Exterior Siding:
 - 1) Standard SmartSide® Lap Siding
 - 2) Installed over OSB Sheathing and Housewrap
 - g. Finished Interior Walls:
 - 1) Interior Walls Covered with a Minimum Thickness of 1/2" (0.5") Medium Density Overlay (MDO) Fir Plywood Manufactured with 100% Waterproof Adhesives and Coated with Resin Treated Fiber Overlay that Provides Smooth Painting Surface, Seams Sealed with Caulk and Covered with Wood Batten Trim Strips
 - 2) Interior Wall Surface and Wood Trim Hand Spackled, Sanded and Sealed with Exterior Grade Primer and Paint Finish
 - h. Includes Carbon Steel Anchoring Hardware, Epoxy and Lifting Eye Bolts
 - 2. PESDO - Stamped and Sealed Drawings and Calculations by a Licensed Professional Engineer of Record in the State of Project Location
 - 3. Options (Home Dugout Only):
 - a. EDSC - Storage Closet
 - 1) Size: 12' x 8'
 - 2) Fully Integrated with Enclosed Dugout
 - 3) Includes One (1) 3'W x 6'-8"H Galvannealed 18 Gauge Steel Hollow Door with Honeycomb Flush Core, Galvannealed 16 Gauge Steel Door Frame, Three (3) Stainless Steel Hinges, One (1) Lever Handle and Lockset, One (1) Door Sweep, One (1) Closer, One (1) Threshold and One (1) Weatherstrip, Door and Door Frame Receive a Powder Coated Primer and Finish
 - 4) Interior Walls Finished with Primed 7/16" Oriented Strand Board (OSB) Panels Attached 18 Gauge Flange Steel Studs
 - 4. ED8X40ELEC - Standard Electrical Package Includes Four (4) Overhead Lights, Two (2) Light Switches, Three (3) Dual Outlet Receptacles and One (1) Junction Box for Electrical Supply Connection by Others
 - 5. SUAHCWM - Aluminum Wall Mounted Helmet Cubby
 - a. Pre-Assembled All-Weather Aluminum Wall Mounted Helmet Cubby Unit:
 - 1) Overall Dimensions: 1'-3/4"H x 4'L x 1'-4-3/16"D

- 2) Constructed with Formed .090" 5052 Aluminum Sheet and Stainless Steel Domed Rivets
 - 3) Durable Powder Coated Finish
 - (a) Weather Resistant and Unsusceptible to Rust
 - (b) Choose From Various Standard Color Options, Color to be Confirmed with Owner prior to construction.
 - 4) Helmet Cubbies: Four (4) 10-3/4" x 10-3/4" x 16" D
 - 5) Combine Multiple Units to Desired Overall Length
 - 6) Wall Mounting Hardware Not Included (Varies by Application)
 - 7) 5-Year Manufacturer's Limited Product Warranty
6. PTBTT - Two Tier Polyboard Team Bench
- a. Standard Length: 15'
 - b. Fully Welded Frae Fabricated with 1/8" (0.125") Formed Aluminum and 2" x 2" x 1/8" (0.125") Square Aluminum Tubing
 - 1) Durable Powder Coated Finish
 - 2) Weather Resistant and Unsusceptible to Rust
 - 3) Choose From Various Standard Color Options - Finish Black
 - c. 2" x 4" and 2" x 6" Synthetic Polyboard Seat and Backrest Planking Material
 - 1) Durable and Wear Resistant Solid Core Construction
 - 2) Guaranteed Not to Crack, Splinter, or Sliver
 - 3) Manufactured From 90% Recycled Post Consumer Plastic
 - 4) Choose From Various Standard Color Options, Color to be Confirmed with Owner prior to construction.
 - 5) Custom: Include Polyboard Planking fastened to front of Bench Riser to enclose void space under seat.
 - d. 100% Preassembled; On-Site Assembly NOT Required
 - e. Two Tier Design Permits Player Seating on Bench or Upper Shelf
 - f. Includes Mounting Brackets and Concrete Anchors for Surface Mounting
 - g. 5-Year Manufacturer's Limited Product Warranty
7. SUAHC12BBSS - Helmet, Bat Bin and Side Storage Stand-Up Cubby Unit
- a. Overall Dimensions: 4'W x 6'-5-15/16"H x 3'-5/16"D
 - b. Constructed with Formed .090" 5052 Aluminum Sheet and Stainless Steel Domed Rivets
 - c. Durable Powder Coated Finish
 - 1) Weather Resistant and
 - 2) Choose From Various Standard Color Options, Color to be Confirmed with Owner prior to
 - d. Helmet Cubbies: Twelve (12)
 - e. Bat Bins: Eight (8)
 - f. 5-Year Manufacturer's Limited Product Warranty

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Verify that all site work related is adequate.
- B. Verify that fields are laid out in accordance with the NYSPHSAA - New York State Public High School Athletic Association and NFHS (Guide)
- C. Materials delivered to the site shall be examined for damage or defects in shipping. Any defects shall be noted and reported to the Owners representative. Replacements, if necessary, shall be immediately reordered, so as to minimize any conflict with the construction schedule. Sound materials shall be stored above ground under protective cover or indoors so as to provide proper protection.

3.2 INSTALLATION

- A. Equipment shall be installed by experienced workmen in exact accordance with the manufacturer's specifications and approved shop drawings.
- B. Equipment shall be installed to the location, dimension and alignment in accordance with the contract drawings and/or accepted standards for the specific.
- C. Equipment shall be installed in accordance with NYSPHSAA - New York State Public High School Athletic Association and NFHS (Guide) - National Federation of High School Associations - Court and Field Diagram Guide; current edition.

3.3 CLOSEOUT ACTIVITIES

- A. Demonstrate proper operation of equipment to Owner's designated representative.
- B. 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.
- C. 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.

3.4 MAINTENANCE

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

END OF SECTION

SECTION 32 91 19
LANDSCAPE GRADING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Topsoil placement.
- B. Finish grading.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading.
- B. Section 31 23 23 - Fill.
- C. Section 32 92 19 - Seeding.
- D. Section 32 92 23 - Sodding.

1.3 REFERENCE STANDARDS

- A. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).
- B. ASTM D5268 - Standard Specification for Topsoil Used for Landscaping and Construction Purposes; 2023.
- C. ASTM F1647 - Standard Test Method for Organic Matter Content of Athletic Field Rootzone Mixes; 2011 (Reapproved 2018).

1.4 SUBMITTALS

- A. Project Record Documents: Accurately record actual locations of utilities remaining by horizontal dimensions, elevations or inverts, and slope gradients.
- B. Soil Samples: 10 pounds sample of each type of topsoil; submit in air-tight containers to testing laboratory.
 - 1. Provide test of topsoil at a rate of one sample per 100 cubic yards.
 - 2. Stockpiled on-site topsoil shall be sampled from multiple locations within the stockpile.
- C. Field Quality Control Submittals: Topsoil depth measurements.

1.5 FIELD CONDITIONS

- A. Place topsoil during dry weather.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Topsoil: Comply with ASTM D5268.
- B. Topsoil: Topsoil excavated on-site.

1. Select.
 2. Free of roots, lumps larger than inches, rocks larger than 1-1/2 inch, subsoil, debris, large weeds and foreign matter.
 3. Acidity Range (pH): 5.5 to 7.5.
 4. Comply with ASTM D2487 Group Symbol OH.
 5. Disturbed soil shall be minimally mechanically raked to smooth soil and remove stone.
- C. Topsoil: Topsoil excavated on-site, tested and amended as required to meet the following:.
1. Select.
 2. Handle excavated topsoil in accordance with Section 31 22 00 - Grading.
 3. Double screened on site prior to placement.
 4. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter, including but not limited to woody material, trash and glass.
 5. Acidity range (pH) of 5.5 to 7.5.
 6. Complying with ASTM D2487 Group Symbol OH.
 7. Disturbed soil shall be minimally mechanically raked to smooth soil and remove stone.
- D. Topsoil: Friable loam; imported borrow.
1. Select.
 2. Free of roots, rocks larger than 1/2 inch, subsoil, debris, large weeds and foreign matter.
 3. Acidity range (pH) of 5.5 to 7.5.
 4. Containing a minimum organic matter of 4 percent of total content by volume, when tested in accordance with ASTM F1647, Test Method A.
 5. Complying with ASTM D2487 Group Symbol OH.
 6. USDA Textural Soil Classification: Percentage of clay, silt, and sand; defined as Sandy Loam.
 - a. Assume 1:3 sand to topsoil ratio to meet requirements.
 7. Investigate imported soil supply prior to bidding and include necessary amendments.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify grading and intended elevations are as indicated on drawings.
- B. Verify absence of standing or ponding water.

3.2 PREPARATION

- A. Protect site features to remain, including bench marks, survey control points, existing structures, fences, sidewalks, paving, and curbs.
- B. Protect trees, plants, lawns, rock outcroppings, and other features to remain.
- C. Remove debris, roots, branches, stones, in excess of 1/2 inch in size.
- D. Scarify trafficked surface to a minimum depth of 8 inches.
- E. Follow State's best practice for decompaction and deep ripping all surfaces impacted by construction.
- F. Grade substrate, see Section 31 22 00.

3.3 TOPSOIL PLACEMENT

- A. Uniformly distribute and spread topsoil.
- B. Place topsoil in areas where seeding, sodding, and planting as indicated on drawings.
- C. Place topsoil to the following compacted thicknesses:
 1. Areas Indicated Seeded with Grass: 6 inches.

2. Areas Indicated as Sodded: 4 inches.
3. Shrub Beds: 18 inches.
4. Flower Beds: 12 inches.

3.4 FINISH GRADING

- A. Maintain profiles and contour of subgrade.
- B. Remove roots, weeds, rocks, and foreign material while spreading.
- C. Maintain uniform topsoil thickness.
- D. Lightly compact placed topsoil.
- E. Regrade or add topsoil where settling occurs during lawn establishment.

3.5 TOLERANCES

- A. Topsoil Thickness: 1/2 inch plus/minus.

3.6 CLEANING

- A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
- B. Remove unused topsoil. Grade stockpile area to prevent standing water.

3.7 PROTECTION

- A. Protect from stormwater runoff and subsequent construction operations.
- B. Do not permit traffic until established.
- C. Provide appropriate stakes, flags, or signage along sidewalk(s) or other areas where foot or vehicle traffic is possible until lawn is established.

END OF SECTION

SECTION 32 92 19
SEEDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Placing topsoil.
- C. Seeding, mulching and fertilizer.
- D. Maintenance.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of subsoil topsoil in preparation for the work of this section.
- B. Section 32 01 90 - Operation and Maintenance of Planting: Post-occupancy maintenance.
- C. Section 32 91 19 - Landscape Grading: Topsoil placement and finish grading.

1.3 REFERENCE STANDARDS

- A. ASTM D7322/D7322M - Standard Test Method for Determination of Erosion Control Product (ECP) Ability to Encourage Seed Germination and Plant Growth Under Bench-Scale Conditions; 2017.

1.4 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.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Topsoil samples.
- C. Product Data: Submit data for seed mix, fertilizer, mulch, and other accessories.
- D. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- E. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer .

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.

1.7 QUALIFICATIONS

- A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

PART 2 PRODUCTS

2.1 SEED MIXTURE

- A. Seed Mixture: General Lawn Areas, Evergreen Professional 80/20 mix by Banfield Baker or approved equal
 - 1. 40% Diva Kentucky Bluegrass
 - 2. 40% Guinness Kentucky Bluegrass
 - 3. 10% Palmer IV Perennial Ryegrass
 - 4. 10% Double Time Perennial Ryegrass
- B. Seed Mixture: Athletic Fields - Sunny mix:
 - 1. 50% Improved Kentucky Bluegrass.
 - 2. 50% Improved Perennial Ryegrass.
 - 3. Seeding Rate: 4 lbs./1,000sqft.

2.2 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

2.3 ACCESSORIES

- A. Mulching Material: Oat or wheat straw, free from weeds, foreign matter detrimental to plant life, and dry. Hay or chopped cornstalks are not acceptable.
- B. Mulching Material: Pelleted, biodegradable, dry recycled paper fiber, free from weeds, formulated to absorb and release water continually during seeding establishment.
 - 1. Integral tackifier and starter fertilizer.
 - 2. Manufacturer:
 - a. Lebanon Turf; PennMulch: www.lebanonturf.com.
 - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- D. Erosion Fabric: Jute matting, open weave. Provide on all disturbed slopes of 3:1 or greater.

2.4 TESTS

- A. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- B. Submit minimum 10 oz sample of topsoil proposed. Forward sample to approved testing laboratory in sealed containers to prevent contamination.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

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. Prepare subgrade in accordance with Section 31 22 00.
- B. Place topsoil in accordance with Section 32 91 19.

3.3 FERTILIZING

- A. Apply fertilizer at a rate of soil analysis recommendations.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.4 SEEDING

- A. Apply seed at a rate of 10 lbs per 1000 sq ft evenly in two intersecting directions. Rake in lightly.
- B. Do not seed areas in excess of that which can be mulched on same day.
- C. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- D. Roll seeded area with roller not exceeding 112 lbs.
- E. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
 - 1. Where pelleted mulch is incorporated, apply at manufacturer's recommended rate of coverage.
- F. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- G. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.5 HYDROSEEDING

- A. Apply seeded slurry with a hydraulic seeder at a rate of 10 lbs per 1000 sq ft evenly in two intersecting directions.
- B. Do not hydroseed area in excess of that which can be mulched on same day.
- C. Immediately following seeding, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.
- D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.
- E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.6 PROTECTION

- A. Cover seeded slopes where grade is 36 inches per foot or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.
- B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.
- C. Secure outside edges and overlaps at 36 inch intervals with stakes.
- D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
- E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

3.7 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.
- B. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.
- C. Maintain seeded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- D. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.
- E. Neatly trim edges and hand clip where necessary.
- F. Immediately remove clippings after mowing and trimming.
- G. Water to prevent grass and soil from drying out.
- H. Roll surface to remove minor depressions or irregularities.
- I. Control growth of weeds.
- J. Immediately reseed areas that show bare spots.
- K. Protect seeded areas with warning signs during maintenance period.

END OF SECTION

SECTION 32 92 23
SODDING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Fertilizing.
- C. Sod installation.
- D. Maintenance.

1.2 RELATED REQUIREMENTS

- A. Section 31 22 00 - Grading: Preparation of subsoil in preparation for work of this section.
- B. Section 32 01 90 - Operation and Maintenance of Planting: Post-occupancy maintenance.
- C. Section 32 91 19 - Landscape Grading: Topsoil placement and finish grading.

1.3 DEFINITIONS

- A. Weeds: Includes 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.

1.4 REFERENCE STANDARDS

- A. TPI (SPEC) - Guideline Specifications to Turfgrass Sodding; 2006.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Certificate: Certify grass species and location of sod source.

1.6 QUALITY ASSURANCE

- A. Sod Producer: Company specializing in sod production and harvesting with minimum five years experience, and certified by the State of New York.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sod on pallets. Protect exposed roots from dehydration.
- B. Do not deliver more sod than can be laid within 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of fertilizer and herbicide mixture.

2.2 MATERIALS

- A. Sod: TPI (SPEC), Certified Turfgrass Sod quality; cultivated grass sod; type indicated in plant schedule on Drawings; with strong fibrous root system, free of stones, burned or bare spots; containing no more than 5 weeds per 1000 sq ft. Minimum age of 18 months, with root development that will support its own weight without tearing, when suspended vertically by holding the upper two corners.
 - 1. Kentucky Blue Grass Type: 100 percent.
 - 2. Machine cut sod and load on pallets in accordance with TPI (SPEC) Guidelines.
- B. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay, or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.
- C. Fertilizer: recommended for grass, with fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.
- D. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.

2.3 SOURCE QUALITY CONTROL

- A. Provide analysis of topsoil fill under provisions of Section 01 40 00.
- B. Analyze to ascertain percentage of nitrogen, phosphorus, potash, soluble salt content, organic matter content, and pH value.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

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. Prepare subgrade in accordance with Section 31 22 00.
- B. Place topsoil in accordance with Section 32 91 19.

3.3 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to installation of sod.
- C. Apply fertilizer no more than 48 hours before laying sod.
- D. Mix thoroughly into upper 2 inches of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.

3.4 LAYING SOD

- A. Moisten prepared surface immediately prior to laying sod.
- B. Lay sod immediately after delivery to site to prevent deterioration.
- C. Lay sod smooth and tight with no open joints visible, and no overlapping; stagger end joints 12 inches minimum. Do not stretch or overlap sod pieces.
- D. Where new sod adjoins existing grass areas, align top surfaces.
- E. Where sod is placed adjacent to hard surfaces, such as curbs, pavements, etc., place top elevation of sod 1/2 inch below top of hard surface.
- F. On slopes 6 inches per foot and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2 feet on center. Drive pegs flush with soil portion of sod.
- G. Water sodded areas immediately after installation. Saturate sod to 4 inches of soil.
- H. After sod and soil have dried, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities. Roll sodded areas with roller not exceeding 110 lbs.

3.5 MAINTENANCE

- A. See Section 32 01 90 - Operation and Maintenance of Planting for post-occupancy maintenance.
- B. Provide maintenance at no extra cost to Owner; Owner will provide water.
- C. Maintain sodded areas immediately after placement until grass is well established and exhibits a vigorous growing condition.
- D. Mow grass at regular intervals to maintain at a maximum height of 2-1/2 inches. Do not cut more than 1/3 of grass blade at any one mowing.
- E. Neatly trim edges and hand clip where necessary.
- F. Immediately remove clippings after mowing and trimming.
- G. Water to prevent grass and soil from drying out.
- H. Roll surface to remove irregularities.
- I. Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.
- J. Immediately replace sod to areas that show deterioration or bare spots.
- K. Protect sodded areas with warning signs during maintenance period.

END OF SECTION

SECTION 32 93 00
PLANTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Preparation of subsoil.
- B. Topsoil bedding.
- C. New trees.
- D. Mulch and Fertilizer.
- E. Maintenance.
- F. Tree Pruning.

1.2 RELATED REQUIREMENTS

- A. Section 32 91 19 - Landscape Grading: Topsoil placement and finish grading.

1.3 DEFINITIONS

- A. Weeds: Any plant life not specified or scheduled.
- B. Plants: Living trees, plants, and ground cover specified in this Section , and described in ANSI Z60.1.

1.4 REFERENCE STANDARDS

- A. ANSI/AHIA Z60.2 - American Standard for Nursery Stock; 2025.
- B. ANSI A300 Part 1 - American National Standard for Tree Care Operations - Tree, Shrub, and Other Woody Plant Management - Standard Practices (Pruning); 2017.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Maintenance Data: Include cutting and trimming method; types, application frequency, and recommended coverage of fertilizer.
- C. Submit list of plant life sources.
- D. Maintenance Contract.

1.6 QUALITY ASSURANCE

- A. Nursery Qualifications: Company specializing in growing and cultivating the plants with three years documented experience.
- B. Installer Qualifications: Company specializing in installing and planting the plants with 5 years experience.
- C. Tree Pruner Qualifications: Company specializing in pruning trees with proof of Arborist Certification.
- D. Tree Pruning: Comply with ANSI A300 Part 1.

- E. Maintenance Services: Performed by installer.
- F. Non-native, Invasive Plant Species: Do not introduce, grow, or cultivate plant species that are non-native to the ecosystem of the project site, and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.
 - 1. Comply with laws regulating non-native and invasive plant species in the State of New York.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- B. Protect and maintain plant life until planted.
- C. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.8 FIELD CONDITIONS

- A. Do not install plant life when ambient temperatures may drop below 35 degrees F or rise above 90 degrees F.
- B. Do not install plant life when wind velocity exceeds 30 mph.

1.9 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide one year warranty.
- C. Warranty: Include coverage for one continuous growing season; replace dead or unhealthy plants.
- D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.

PART 2 PRODUCTS

2.1 PLANTS

- A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.2 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.

2.3 SOIL AMENDMENT MATERIALS

- A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.
- B. Peat Moss: Shredded, loose, sphagnum moss; free of lumps, roots, inorganic material or acidic materials; minimum of 85 percent organic material measured by oven dry weight, pH range of 4 to 5; moisture content of 30 percent.
- C. Bone Meal: Raw, finely ground, commercial grade, minimum of 3 percent nitrogen and 20 percent phosphorous.
- D. Lime: Ground limestone, dolomite type, minimum 95 percent carbonates.

PLANTS

- E. Water: Clean, fresh, and free of substances or matter that could inhibit vigorous growth of plants.

2.4 MULCH MATERIALS

- A. Mulching Material: Double Ground Hardwood Dark Brown in color species wood shavings, free of growth or germination inhibiting ingredients.

2.5 ACCESSORIES

- A. Wrapping Materials: Burlap.
- B. Stakes: Softwood lumber, pointed end.
- C. Cable, Wire, Eye Bolts and Turnbuckles: Non-corrosive, of sufficient strength to withstand wind pressure and resulting movement of plant life.
- D. Plant Protectors: Rubber sleeves over cable to protect plant stems, trunks, and branches.
- E. Landscape Fabric: Non-woven, needle punched, polypropylene, fabric; Mirafi MSCAPE, or approved equal.

2.6 PLANT SOIL MIX

- A. A uniform mixture of 1 part peat and 3 parts topsoil by volume.

2.7 SOURCE QUALITY CONTROL

- A. Provide analysis of topsoil; comply with requirements of Section 01 40 00.
- B. Provide testing of imported topsoil.
- C. Testing is not required if recent tests are available for imported topsoil. Submit these test results to the testing laboratory for approval. Indicate, by test results, information necessary to determine suitability.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that prepared subsoil and planters are ready to receive work.
- B. Saturate soil with water to test drainage.
- C. Verify that required underground utilities are available, in proper location, and ready for use.

3.2 PREPARATION OF SUBSOIL

- A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
- B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
- C. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
- D. Dig pits and beds 6 inches larger than plant root system.

3.3 PLACING TOPSOIL

- A. Spread topsoil to a minimum depth of 4 inches over area to be planted. Rake smooth.
- B. Place topsoil during dry weather and on dry unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
- D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
- E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

3.4 FERTILIZING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after initial raking of topsoil.
- C. Mix thoroughly into upper 2 inches of topsoil.
- D. Lightly water to aid the dissipation of fertilizer.

3.5 PLANTING

- A. Place plants for best appearance for review and final orientation by Architect.
- B. Set plants vertical.
- C. Remove non-biodegradable root containers.
- D. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from the root ball.
- E. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.6 INSTALLATION OF ACCESSORIES

- A. Wrap deciduous shade and flowering tree trunks and place tree protectors.

3.7 PLANT SUPPORT

- A. Brace plants vertically with plant protector wrapped guy wires and stakes to the following:
 - 1. Tree Caliper: 1 inch; Tree Support Method: 1 stake with one tie
 - 2. Tree Caliper: 1 to 2 inches; Tree Support Method: 2 stakes with two ties
 - 3. Tree Caliper: 2 to 4 inches; Tree Support Method: 3 stakes with 2 ties
 - 4. Tree Caliper: Over 4 inches; Tree Support Method: 4 guy wires with eye bolts and turn buckles

3.8 TREE PRUNING

- A. Prune trees as recommended in ANSI A300 Part 1.
- B. Prune newly planted trees as required to remove dead, broken, and split branches.

3.9 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Plants will be rejected if a ball of earth surrounding roots has been disturbed or damaged prior to or during planting.

3.10 MAINTENANCE

- A. Provide maintenance at no extra cost to Owner; Owner will pay for water.

- B. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
- C. Provide a separate maintenance contract for specified maintenance service.
- D. Maintain plant life immediately after placement and until plants are well established and exhibit a vigorous growing condition. Continue maintenance until termination of warranty period.
- E. Irrigate sufficiently to saturate root system and prevent soil from drying out.
- F. Remove dead or broken branches and treat pruned areas or other wounds.
- G. Neatly trim plants where necessary.
- H. Immediately remove clippings after trimming.
- I. Control growth of weeds.
- J. Control insect damage and disease.
- K. Maintain wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles to keep guy wires tight. Repair or replace accessories when required.

END OF SECTION

SECTION 33 01 10.58
DISINFECTION OF WATER UTILITY PIPING SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Disinfection of site domestic water lines and site fire water lines specified in Section 33 14 16.
- B. Disinfection of building domestic water piping specified in Section 22 10 05.
- C. Testing and reporting results.

1.2 RELATED REQUIREMENTS

- A. Section 22 10 05 - Plumbing Piping and Specialties: Disinfection of building domestic water piping system.
- B. Section 33 14 16 - Water Utility Distribution Piping.

1.3 REFERENCE STANDARDS

- A. AWWA B300 - Hypochlorites; 2024.
- B. AWWA B301 - Liquid Chlorine; 2024.
- C. AWWA B302 - Ammonium Sulfate; 2023.
- D. AWWA B303 - Sodium Chlorite; 2024.
- E. AWWA C651 - Disinfecting Water Mains; 2023.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Test Reports: Indicate results comparative to specified requirements.
- C. Certificate: From authority having jurisdiction indicating approval of water system.
- D. Certificate: Certify that cleanliness of water distribution system meets or exceeds specified requirements.
- E. 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.
- F. 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.

7. Certification that water complies, or fails to comply, with bacterial standards of the Authorities Having Jurisdiction.

1.5 QUALITY ASSURANCE

- A. Water Treatment Firm: Company specializing in disinfecting potable water systems specified in this Section with minimum three years documented experience.
- B. Testing Firm: Company specializing in testing potable water systems, certified by governing authorities of the State of New York.
- C. Submit bacteriologist's signature and authority associated with testing.

PART 2 PRODUCTS

2.1 DISINFECTION CHEMICALS

- A. Chemicals: AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, AWWA B303 Sodium Chlorite, AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, AWWA B303 Sodium Chlorite, AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, AWWA B303 Sodium Chlorite, AWWA B300 Hypochlorite, AWWA B301 Liquid Chlorine, AWWA B302 Ammonium Sulfate, and AWWA B303 Sodium Chlorite.

PART 3 EXECUTION

- 3.1 NO HEAVILY CHLORINATED WATER SHALL BE DISCHARGED INTO ANY WATERWAY OR SEWER SYSTEM. A MINIMUM OF 150' OF OVERLAND FLOW SHALL BE REQUIRED BEFORE ENTERING THE ABOVE REFERENCED DISCHARGE LOCATIONS. IN ALL CASES, HEAVILY CHLORINATED WATER DISPOSAL SHALL BE IN ACCORDANCE WITH AWWA C651 - SECTION 6.2, AND APPENDIX B.

3.2 PRELIMINARY FLUSHING

- A. The main shall be flushed prior to disinfection at a flushing velocity of not less than 3 ft/sec. The rate of flow required to produce this velocity in various diameters is shown below.

Required Opening to Flush Pipelines (40-psi Residual Pressure)	
Pipe size in.	Flow required to produce 3 fps velocity gpm
6	270
8	470
10	730
12	1100
14	1440

- 3.3 NO SITE FOR FLUSHING SHOULD BE CHOSEN UNLESS IT HAS BEEN DETERMINED THAT DRAINAGE IS ADEQUATE AT THAT SITE.

3.4 FORM OF CHLORINE FOR DISINFECTION

- A. The most common forms of chlorine used in the disinfecting solutions are calcium hypochlorite granules or sodium hypochlorite solutions.

- B. Calcium Hypochlorite: Calcium hypochlorite contains 70 percent available chlorine by weight. calcium hypochlorite is packaged in containers of various types and sizes ranging from small plastic bottles to 100-lb drums.
1. A chlorine-water solution is prepared by dissolving the granules in water in the proportion requisite for the desired concentration.
- C. Sodium Hypochlorite: Sodium hypochlorite is supplied in strengths from 5.25 to 16 percent available chlorine. It is packaged in liquid form in glass, rubber or plastic containers ranging in size from 1-qt. bottles to 5-gal. carboys. It may also be purchased in bulk for delivery by tank truck.
1. The chlorine-water solution is prepared by adding hypochlorite to water. Product deterioration must be reckoned with in computing the quantity of sodium hypochlorite required for the desired concentration.
 2. Application: The hypochlorite solutions shall be applied to the water main with a gasoline or electrically-powered chemical feed pump designed for feeding chlorine solutions. For small applications the solutions may be fed with a hand pump, for example, a hydraulic test pump. Feed lines shall be of such material and strength as to withstand safely the maximum pressures that may be created by the pumps. All connections shall be checked for tightness before the hypochlorite solution is applied to the main.

3.5 METHODS OF CHLORINE APPLICATION

- A. Continuous Feed Method: This method is suitable for general application.

- B. Chlorine Required to Produce 50 Mg/l Concentration in 100 ft. of Pipe by Diameter

Pipe size in.	100 percent chlorine - lb.	1 percent chlorine solutions - gal.
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.327	3.92

- C. Water from the existing distribution system or other approved sources of supply shall be made to flow at a constant, measured rate. The two rates shall be proportioned so that the chlorine concentration in the water in the pipe is maintained at a minimum of 50 mg/L available chlorine. To assure that this concentration is maintained, the chlorine residual should be measured at regular intervals in accordance with the procedures described in the current edition of Standard Methods and AWWA M12-Simplified Procedures for Water Examination.
1. NOTE: In the absence of a meter, the rate may be determined either by placing a Pitot gage at the discharge or by measuring the time to fill a container of known volume.
- D. The table in paragraph above gives the amount of chlorine residual required for each 100 ft. of pipe of various diameters. Solutions of 1 percent chlorine may be prepared with sodium hypochlorite or calcium hypochlorite. The latter solution requires approximately 1 lb. of calcium hypochlorite in 8.5 gal of water.
- E. During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the line supplying the water. Chlorine application shall not cease until the entire main is filled with the chlorine solution. The chlorinated water shall be retained in the main for at least 24 hr., during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this 24 hr. period, the treated water shall contain no less than 25 mg/L chlorine throughout the length of the main.

3.6 EXAMINATION

- A. Verify that piping system has been cleaned, inspected, and pressure tested.
- B. Schedule disinfecting activity to coordinate with start-up, testing, adjusting and balancing, demonstration procedures, including related systems.

3.7 DISINFECTION - PIPING

- A. Use method prescribed by the applicable state or local codes, or health authority or water purveyor having jurisdiction, or in the absence of any of these follow AWWA C651.
- B. Disinfection injection/ sampling taps shall be installed along the length of pipe at a distance no greater than 1,000 feet.
- C. Provide and attach equipment required to perform the work.
- D. Inject treatment disinfectant into piping system.
- E. Maintain disinfectant in system for 24 hours.
- F. Flush, circulate, and clean until required cleanliness is achieved; use municipal domestic water.
- G. Replace permanent system devices removed for disinfection.
- H. Pressure test system to 200 psi. Repair leaks and re-test.

3.8 FINAL FLUSHING

- A. After the applicable retention period, the heavily chlorinated water shall be flushed from the main until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/L. Chlorine residual determination shall be made to ascertain that the heavily chlorinated water has been removed from the pipeline.

3.9 BACTERIOLOGIC TESTS

- A. After final flushing, and before the water main is placed in service, a sample or samples shall be collected from the end of the line and tested for bacteriologic quality and shall show the absence of coliform organisms. If the number and frequency of samples is not prescribed by the public health authority having jurisdiction, at least two samples shall be collected from throughout the new main from unchlorinated supplies. Samples shall be collected at least 24 hours apart.
 - 1. NOTE: In the case of extremely long mains, it is desirable that samples be collected the length of the line as well as at its end.
- B. Samples for bacteriologic analysis shall be collected in sterile bottles treated with sodium thiosulphate. No hose or fire hydrant shall be used in collection of samples. A suggested sampling tap consists of a standard corporation cock installed in the main with a copper tube gooseneck assembly. After samples have been collected the gooseneck assembly may be removed, and retained for future use.

3.10 REPETITION OF PROCEDURE

- A. If the initial disinfection fails to produce satisfactory samples, disinfection shall be repeated until satisfactory samples have been obtained.

3.11 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.
- B. Test samples in accordance with AWWA C651.

END OF SECTION

SECTION 33 05 24
UTILITY HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. The work specified in this section consists of furnishing and installing underground utilities using the horizontal directional drilling (HDD) method of installation, also commonly referred to as directional boring or guided horizontal boring. This work shall include all services, equipment, materials, and labor for the complete and proper installation, testing, restoration of underground utilities and environmental protection and restoration.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation.
- B. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems.
- C. Section 33 14 16 - Water Utility Distribution Piping.

1.3 REFERENCES

- A. The following standards contain provisions that, through reference in this text, constitute provisions of these guidelines. All standards are subject to revision, and users of these guidelines are cautioned to use the latest revisions.
- B. NYSDOT - Section 650 - Trenchless Installation of Casing.

1.4 SUBMITTALS

- A. WORK PLAN: Prior to beginning work, the Contractor must submit to the Engineer a general work plan outlining the procedure and schedule to be used to execute the project. Plan should document the thoughtful planning required to successfully complete the project.
- B. EQUIPMENT: Contractor will submit specifications on equipment being used including make and model number and specifications (catalog cuts) of all major equipment proposed for use on the project. The Contractor is responsible for the final determination of the drill rig size based on the length and depth of the actual runs, the subsurface conditions expected, etc..
- C. MATERIAL: Specifications on material to be used shall be submitted to Engineer. Material shall include the pipe, fittings and any other item which is to be an installed component of the project.
- D. PERSONNEL: Documentation of training and relevant experience of personnel shall be submitted. Qualifications of the Contractor showing that all directional drilling operations will be performed by a competent driller with a minimum of five (5) years of relevant experience. Completed projects with details of the types of pipe installations, owner contact names and telephone numbers must be included.

1.5 QUALITY ASSURANCE

- A. The requirements set forth in this document specify a wide range of procedural precautions necessary to insure that the very basic, essential aspects of a proper directional bore installation are adequately controlled. Strict adherence shall be required under specifically covered conditions outlined in this specification. Adherence to the specifications contained herein, or the Engineer's approval of any aspect of any directional bore operation covered by this specification, shall in no way relieve the Contractor of their ultimate responsibility for the satisfactory completion of the work authorized under the Contract.

PART 2 PRODUCTS

2.1 EQUIPMENT

- A. The directional drilling equipment shall consist of a directional drilling rig of sufficient capacity to perform the bore and pullback the pipe, a drilling fluid mixing & delivery system of sufficient capacity to successfully complete the crossing, a guidance system to accurately guide boring operations and trained and competent personnel to operate the system. All equipment shall be in good, safe operating condition with sufficient supplies, materials and spare parts on hand to maintain the system in good working order for the duration of this project.

2.2 DRILLING SYSTEM

- A. DRILLING RIG - The directional drilling machine shall consist of a hydraulically powered system to rotate, push and pull hollow drill pipe into the ground at a variable angle while delivering a pressurized fluid mixture to a guidable drill (bore) head. The machine shall be anchored to the ground to withstand the pulling, pushing and rotating pressure required to complete the crossing. The hydraulic power system shall be self-contained with sufficient pressure and volume to power drilling operations. Hydraulic system shall be free of leaks. Rig shall have a system to monitor and record maximum pull-back pressure during pull-back operations.
- B. DRILL HEAD - The drill head shall be steerable by changing its rotation and shall provide the necessary cutting surfaces and drilling fluid jets.
- C. MUD MOTORS (if required) - Mud motors shall be of adequate power to turn the required drilling tools.
- D. DRILL PIPE - Shall be constructed of high quality 4130 seamless tubing, grade D or better, with threaded box and pins. Tool joints should be hardened to 32-36 RC.

2.3 GUIDANCE SYSTEM

- A. The Guidance System shall be of a proven type and shall be setup and operated by personnel trained and experienced with this system. The Operator shall be aware of any magnetic anomalies and shall consider such influences in the operation of the guidance system if using a magnetic system.

2.4 DRILLING FLUID (MUD) SYSTEM

- A. MIXING SYSTEM - A self-contained, closed, drilling fluid mixing system shall be of sufficient size to mix and deliver drilling fluid composed of bentonite clay, potable water and appropriate additives. Mixing system shall be able to molecularly shear individual bentonite particles from the dry powder to avoid clumping and ensure thorough mixing. The drilling fluid reservoir tank shall be sized for adequate storage of the mud. Mixing system shall continually agitate the drilling fluid during drilling operations.

- B. DRILLING FLUIDS - Drilling fluid shall be composed of clean water and an appropriate additive. Water shall be from a clean source with a pH of 8.5 - 10 and/or as per mixing requirements of the Manufacturer. Water of a lower pH or with excessive calcium shall be treated with the appropriate amount of sodium carbonate or equal. The water and additives shall be mixed thoroughly and be absent of any clumps or clods. No hazardous additives may be used. Drilling fluid shall be maintained at a viscosity sufficient to suspend cuttings and maintain the integrity of bore wall.
- C. DELIVERY SYSTEM - The mud pumping system shall have a minimum capacity to supply mud in accordance with the drilling equipment pull-back rating at a constant required pressure. The delivery system shall have filters in-line to prevent solids from being pumped into the drill pipe. Connections between the pump and drill pipe shall be relatively leak-free. Used drilling fluid and drilling fluid spilled during drilling operations shall be contained and properly disposed of. A berm, minimum of 12" high, shall be maintained around drill rigs, drilling fluid mixing system, entry and exit pits and drilling fluid recycling system (if used) to prevent spills into the surrounding environment. Pumps and or vacuum truck(s) of sufficient size shall be in place to convey excess drilling fluid from containment areas to storage facilities.

2.5 OTHER EQUIPMENT

- A. PIPE ROLLERS - Pipe rollers, if required, shall be of sufficient size to fully support the weight of the pipe while being hydro-tested and during pull-back operations. Sufficient number of rollers shall be used to prevent excess sagging of pipe.
- B. PIPE RAMMERS - Hydraulic or pneumatic pipe rammers may only be used if necessary and with the authorization of Engineer.
- C. RESTRICTIONS - Other devices or utility placement systems for providing horizontal thrust other than those previously defined in the preceding sections shall not be used unless approved by the Engineer prior to commencement of the work. Consideration for approval will be made on an individual basis for each specified location. The proposed device or system will be evaluated prior to approval or rejection on its potential ability to complete the utility placement satisfactorily without undue stoppage and to maintain line and grade within the tolerances prescribed by the particular conditions of the project.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.

3.2 PREPARATION

- A. Do not start work prior to receiving the Engineer's written approval. Approval, if granted, will be based on the decision of the Director, Geotechnical Engineering Bureau (D.G.E.B.) as to the acceptability of the proposed work plan and any variations to provide satisfactory installation of the water supply utilities and avoid damage. The Engineer will forward the proposed work plan to the D.G.E.B. for review. The D.G.E.B. requires twenty (20) working days from the date of receipt of the proposed work plan in the Bureau to perform his review. Approval will remain in force only as long as all conditions set forth in the approval are met and satisfactory results are obtained. In the event that unsatisfactory results and/or damage occurs, the Contractor will stop work and modify his methods and submit them for review and approval.
- B. Shore entrance and exit pits as necessary to meet OSHA requirements.
- C. Protect any existing underground utilities during this work.

- D. Contractor shall place silt fence between all drilling operations and any drainage, wetland, waterway or other area designated for such protection by contract documents, state, federal and local regulations. Additional environmental protection necessary to contain any hydraulic or drilling fluid spills shall be put in place, including berms, liners, turbidity curtains and other measures. Contractor shall adhere to all applicable environmental regulations. Fuel or oil may not be stored in bulk containers within 200' of any water-body or wetland.

3.3 INSTALLATION

- A. Exercise special care and handling during delivery and distribution of water supply utilities to avoid damage. Damaged water supply utilities will be rejected and replaced at the Contractor's expense. Store water supply utilities prior to use in such a manner as to keep the interior free from dirt and foreign material. Thoroughly clean any water supply utility that becomes contaminated before it is incorporated into the work.
- B. The alignment of utility must conform to the following requirements:
 - 1. Choose the ground entry and exit angles such that water supply utilities can be installed along the alignment and profile indicated on the contract plans and to the depths indicated in the Standard Sheets.
 - 2. The entrance point(s) and exit point(s) shall be approved by the Engineer and physically located in the field.
 - 3. The exit point(s) shall be no more than 0.3 meters left or right of the location in the field.
 - 4. The vertical depth, as specified in the New York State Standard Sheets, is the depth to which the utility shall be installed.
 - 5. The Contractor may, with written permission from the Engineer, elect to install the utility at a greater depth than shown in the Standard Sheets.
 - 6. Limit the longitudinal pull so as to prevent any damage of the utility. Continuously monitor the longitudinal pulling forces during pullback of utility.
- C. Direct all drilling operations using steering and tracking systems capable of producing the required alignment. The control system shall provide an angle of inclination reading and the direction in which the cutting tool is pointing. Provide access to the Engineer at all times to all measuring or gauging devices used for the drilling operations including drilling logs maintained by the Contractor.
- D. Adequately support the utility on rollers during the pullback into the pre-drilled hole. Rollers and cradles shall be of the type that will prevent damage to the utility and in sufficient number to prevent overstressing during the pullback procedure. Pullback equipment shall be adequate for the length(s) and depth(s) of the runs and for the soil types encountered.
- E. Pull an additional length of pipe through the entrance pit upon pull back and expose it. The Engineer will examine the pipe for scratches, scores, gouges, cuts and other forms of damage. The permissible depths of gouges and scratches do not exceed ten (10) percent of the wall thickness of the pipe.
- F. Pull an adequate sized tracer wire with the utility.
- G. Take necessary procedures to prevent bentonite leakage.
- H. Supply water for mixing drilling fluid.
- I. Supply portable mud tanks or construct temporary mud pits to contain excess drilling fluids during construction. Upon completion of the utility installation, dispose of any cuttings and excess drilling fluids in a manner consistent with local and State regulations.
- J. In the event that the drill hole must be abandoned before completion of the installation, fill abandoned drill holes with grout to prevent subsidence. Progress new drill holes at the Contractor's expense.

- K. Shutdown of any portion of any water service to make connections with existing mains will be made only with the written approval of the Engineer and the Local Water District. When any service is shut down for such purposes, the work on the connection shall be carried on continuously by the Contractor until the water is again turned into the existing main. Maintain adequate water service and fire protection whenever service is interrupted.
- L. During construction, maintain the site in a neat and orderly condition. At the completion of work, remove all temporary structures erected and materials required for temporary access, drill and pipe staging areas, platforms and drilling fluids. Restore the area to the approximate original conditions.

3.4 FLUSHING, TESTING AND COMPLETION

- A. All pipes should be hydrostatically tested after installation following the guidelines set forth in the Plastics Pipe Institutes "Handbook of Polyethylene Pipe". Pneumatic testing is prohibited.
- B. Contractor to provide Engineer with drilling log of station and depth taken at intervals of 10 ft. or other acceptable interval.

END OF SECTION

SECTION 33 05 61
CONCRETE MANHOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Monolithic concrete manholes with drywells and structures or masonry transition to cover frame, covers, anchorage, and accessories.
- B. Modular precast concrete manholes and structures sections with tongue-and-groove joints with masonry transition to frame, dry wells and structures, covers, anchorage, and accessories.
- C. Masonry manholes, drywells, and structures sections with masonry transition to lid frame, covers, anchorage, and accessories.
- D. Grade adjustments.
- E. Bedding and cover materials.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill.

1.3 REFERENCE STANDARDS

- A. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.
- B. ASTM A48/A48M - Standard Specification for Gray Iron Castings; 2022.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- D. ASTM C55 - Standard Specification for Concrete Building Brick; 2023.
- E. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2020.
- F. ASTM C923/C923M - Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; 2020.
- G. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants; 2009 (Reapproved 2019).
- H. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.

- C. Shop Drawings: Indicate manhole locations, elevations, piping, opening, and opening sizes and elevations of penetrations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Perform work in accordance with Department of Transportation Standards in the State of New York.

1.6 FIELD CONDITIONS

- A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.1 CONCRETE MANHOLES

- A. Weight Rating: H 10 according to AASHTO HB.
- B. Precast Concrete Manholes: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches.
 - 2. Base Thickness: 12 inches.
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Grade Adjustments:
 - 1. Adjustment Ring: Concrete, 6 inches (152 mm) wide, diameter matching frame dimensions, in accordance with ASTM C478/C478M.

2.2 ACCESSORIES

- A. Cover: Removable, lockable; closed cover design; cover molded with identifying name.
 - 1. Sanitary sewer manhole covers are to be water tight.
- B. Proof Load: Medium duty, H-20 loading.
 - 1. Manufacturers:
 - a. American Cast Iron: www.amercast.com.
 - b. Neenah Foundry: www.nfco.com.
- C. Manhole, Catch Basin and Structure Steps: Formed aluminum or polypropylene plastic rungs; 3/4 inch diameter. Formed integral with manhole, catch basin and structure sections.

2.3 CONFIGURATION

- A. Clear Inside Dimensions: As indicated on drawings.
- B. Design Depth: As indicated on drawings.
- C. Clear Lid Opening: As indicated on drawings.
- D. Pipe Entry: Provide openings as indicated on drawings.
- E. Steps: 16 inches wide, 12 inches on center vertically, set into manhole wall as indicated on drawings or required by code.

2.4 BEDDING AND BACKFILL MATERIALS

- A. Bedding: Shall be a minimum six (6) inches of crushed stone or as indicated on drawings in accordance with Section 31 23 23.
- B. Backfill above pipe to grade: Shall be select native fill in accordance with Section 31 23 23 or as indicated on drawings.

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 excavation for manholes is correct.

3.2 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.
- B. Do not install structures where site conditions induce loads exceeding structural capacity of structures.
- C. Inspect precast concrete structures immediately prior to placement in excavation to verify structures are internally clean and free from damage. Remove and replace damaged units.
- D. Excavation and Backfill:
 - 1. Excavate for manholes and structures in accordance with Section 31 23 16 in location and to depth shown. Provide clearance around sidewalls of structure for construction operations.
 - 2. When groundwater is encountered, prevent accumulation of water in excavations. Place manholes, dry well and structures in dry trench.
 - 3. Where possibility exists of watertight structure becoming buoyant in flooded excavation, anchor structure to avoid flotation.

3.3 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.
- B. Precast Concrete Manholes:
 - 1. Place base section plumb and level.
 - 2. Install joint sealant uniformly around section lip.
- C. Grade Adjustments:
 - 1. Place adjacent materials tight, and smooth following design grades.

3.4 MANHOLES - MONOLITHIC

- A. Grout base of shaft sections to achieve slope to exit piping. Trowel smooth. Contour as required to form continuous drainage channel.
- B. Backfill excavations for manholes and structures in accordance with Section 31 23 16, 31 23 23.

3.5 MANHOLES - MODULAR PRECAST CONCRETE

- A. Lift precast components at lifting points designated by manufacturer.
- B. When lowering manholes and structures into excavations and joining pipe to units, take precautions to ensure interior of pipeline and structure remains clean.

- C. Set precast structures bearing firmly and fully on crushed stone bedding, compacted in accordance with provisions of Section 31 23 16, 31 23 23 or on other support system shown on Drawings.
- D. Assemble multi-section structures by lowering each section into excavation. Lower, set level, and firmly position base section before placing additional sections.
- E. Remove foreign materials from joint surfaces and verify sealing materials are placed properly. Maintain alignment between sections by using guide devices affixed to lower section.
 - 1. Joint sealing materials may be installed on site or at manufacturer's plant.
- F. Verify manholes and structures installed satisfy required alignment and grade.
- G. Remove knockouts or cut structure to receive piping without creating openings larger than required to receive pipe. Fill annular space with mortar.
- H. Cut pipe to finish flush with interior of structure.
- I. Shape inverts through manhole and structures as shown on Drawings.

3.6 FRAME AND COVER INSTALLATION

- A. Set frames using mortar and masonry. Install radially laid concrete brick with 1/4 inch thick vertical joints at inside perimeter. Lay concrete brick in full bed of mortar and completely fill joints. Where more than one course of concrete brick is required, stagger vertical joints.
- B. Set frame and cover 2 inches above finished grade for manholes and structures with covers located within unpaved areas to allow area to be graded away from cover beginning 1 inch below top surface of frame.

3.7 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test cast-in-place concrete in accordance with Section 03 30 00.
- C. Vertical Adjustment of Existing Manholes and Structures:
 - 1. Where required, adjust top elevation of existing manholes and structures to finished grades shown on Drawings.
 - 2. Reset existing frames, grates and covers, carefully removed, cleaned of mortar fragments, to required elevation in accordance with requirements specified for installation of castings.
 - 3. Remove concrete without damaging existing vertical reinforcing bars when removal of existing concrete wall is required. Clean vertical bars of concrete and bend into new concrete top slab or splice to required vertical reinforcement, as indicated Drawings.
- D. Vacuum Testing
 - 1. Vacuum testing in accordance with ASTM C1244 and as follows:
 - a. Inflate compression band to effect seal between vacuum base and structure; connect vacuum pump to outlet port with valve open; draw vacuum to 10 inches of Hg; close valve; start test.
 - b. Test:
 - 1) Determine test duration for manhole test from standard table1:
 - 2) Record vacuum drop during test period; when vacuum drop is greater than 1 inch of Hg during test period, repair and retest manhole; when vacuum drop of 1 inch of Hg does not occur during test period, discontinue test and accept manhole.
 - 3) When vacuum test fails to meet 1 inch Hg drop in specified time after repair, repair and retest manhole.
- E. Exfiltration/Infiltration Testing (Alternative Method)

1. All sewers entering and leaving each manhole shall be plugged as for air testing. Those manholes which are constructed in a high ground water table location will be allowed to remain plugged for a period of not less than four (4) hours, after which the quantity of inward leakage accumulation will be measured by bailing and measuring and/or computation against depth of water and diameter of the manhole. Those manholes constructed above the ground water table will be filled with water to the top of the cast iron frame and allowed to stand until the walls are well soaked. The manhole shall then be refilled to the full or overflow point, and remain undisturbed for a period of not less than four (4) hours. The loss of water shall be measured by refilling to the top with a pre measured quantity of water and/or computation against depth of water loss and diameter of the manhole.
2. Allowable leakage (gain or loss) by the respective methods shall not exceed the following:
 - 0.04 gal. per hour, per vertical ft. of depth in barrel section
 - 0.03 gal. per hour, per vertical ft. of depth in cone section
 - 0.02 gal. per hour, per vertical ft. of depth in top section
3. Should any test of any manhole disclose leakage greater than that permitted, the Contractor shall, at his own expense and at no additional cost to the Owner, locate and repair the defects joints and/or pipe until the leakage is within the permitted allowance utilizing materials and methods approved by the Owner/Engineer.

END OF SECTION

SECTION 33 05 77
FIBERGLASS METERING MANHOLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Fiberglass metering manholes.

1.2 REFERENCE STANDARDS

- A. 29 CFR 1910.145 - Accident Prevention Signs and Tags; Current Edition.
- B. 29 CFR 1910.27 - Scaffolds and Rope Descent Systems; Current Edition.
- C. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs; 2023.
- D. ASTM D2563 - Standard Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts; 2008 (Reapproved 2015).
- E. ASTM D3753 - Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Manholes and Wetwells; 2020.
- F. ASTM D638 - Standard Test Method for Tensile Properties of Plastics; 2022.
- G. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials; 2017.
- H. ASTM C581 – Standard Practice for Determining Chemical Resistance of Thermosetting Resins Used in Glass-Fiber-Reinforced Structures Intended for Liquid Service.
- I. ASTM D256 – Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- J. ASTM D785 – Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
- K. ASTM D2584 – Standard Test Method for Ignition Loss of Cured Reinforced Resins.
- L. ASTM D 1941 – Standard Test Method for Open Channel Flow Measurement of Water with the Parshall Flume.
- M. ISO 9826 – Measurement of Liquid Flow in Open Channels – Parshall and SANIIRI Flumes.
- N. JIS B7553 – Parshall Flume Type Flowmeters.
- O. Field Manual for Research in Agricultural Hydrology, Agriculture Handbook No. 224, United States Department of Agriculture.
- P. Trapezoidal Flumes for Open-Channel Flow Measurement, Transactions of the American Society of Engineers, Vol. 3, No. 2, 1960.
- Q. Water Measurement in Small Irrigation Channels Using Trapezoidal Flumes, Transactions of the American Society of Engineers, Vol. 9, No. 3, 1966.
- R. Measuring Water in Small Channels with WSC Flume, Washington Agriculture Experiment Station, Circular 200, 1952.
- S. Trapezoidal Flumes for Measuring Flow in Irrigation Channels, USDA-ARS 41-40, March, 1968.

- T. Generalized Discharge Relations for Cutthroat Flumes, Journal of the Irrigation and Drainage Division, American Society of Civil Engineers, Vol. 98, No. IR4, December, 1974.

1.3 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal requirements.
- B. Product Data: Provide manufacturer's data sheets including product data, installation and handling instructions
- C. Shop Drawings: Provide project specific drawings indicating the following:
 - 1. Overall structure length, width, and height.
 - 2. Critical elevations.
 - 3. Ladder, top, coupling, and primary device orientations.
 - 4. Joints, connections, fasteners.
 - 5. Sizes, spacing, and locations of structural members, ribs, anchoring clips, and dimensional bracing.
 - 6. Materials and thicknesses of construction.
 - 7. Minimum and maximum flow rates.
- D. Design Primary Device level-to-flow Discharge Tables indicating:
 - 1. Flow equations.
 - 2. Submergence transition, where published.
 - 3. Accuracy, where published.
 - 4. Plan view layout showing critical dimensions and primary point of measurement (Ha).
 - 5. Discharge table source.
- E. Samples: Provide 6 inch square samples of representative manhole barrel and flume laminates.
- F. Operation and Maintenance Data.
- G. Manufacturer's Executed Warranty.
- H. Test Data Report.
 - 1. Manhole
 - a. Test result data confirming full compliance with ASTM D3753 for manhole barrel and reducer structures as required under Section 11 of the standard.
 - 2. Flume
 - a. Test results confirming flume material properties.

1.4 QUALITY ASSURANCE

- A. Fabricator's Certificate of Compliance with fabrication requirements.
- B. Qualifications of fabricator's Quality Assurance Supervisor.
- C. Copy of fabricator's Quality Assurance Program.
- D. Quality Assurance Inspection with:
 - 1. In-production Quality Assurance Inspection report(s).
 - 2. Certificate of post-production Quality Assurance Inspection report(s).

1.5 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 - Product Requirements for additional requirements.
- B. Verify accuracy of order on delivery. Inspect products for damage incurred during delivery.
- C. Follow manufacturer's recommendations for handling and moving product, including use of fabric slings, spreader bars, lifting eyes, and tag lines.

- D. Manholes not intended for immediate installation may be stored until the site is ready for their installation.
 - 1. Manholes should only be stored in a location that is clean, level, free of sharp objects and protected from construction traffic.
 - 2. When shipped on pallets, manholes should be left on those pallets until such time as they are needed. Care should be taken to ensure that the base flange and end connections are protected from damage. Tarp or cover any manhole to be stored for an extended period of time before installation.
 - 3. Chocks and / or tie downs should be used to prevent rolling or movement due to wind.

1.6 WARRANTY

- A. Packaged Metering Manholes shall be warranted to be free of defects in workmanship and materials for five years with a completed warranty registration.
- B. The warranty period shall begin from the date of shipment.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. Openchannelflow: www.openchannelflow.com.
- B. Or Engineer Approved Equal.
- C. Substitutions: See Section 01 60 00 - Product Requirements for substitution procedures.

2.2 SYSTEM DESCRIPTION

- A. Configuration
 - 1. Packaged Metering Manholes shall be watertight, corrosion resistant units consisting of manhole barrel, top, confined space entry warning sign, coupling, flume with end adapters, end connections, base, and mounting flange.
 - 2. Diameter
 - a. 48 inches I.D.
 - b. Inside diameter tolerance: +/- 1%.
 - 3. Top style
 - a. Aluminum top
 - 1) A two-thirds opening aluminum cover rated for 300 psf pedestrian loading, mounted at the top of the manhole barrel and constructed from 1/4 inch thick aluminum diamond plate with stainless steel hardware.
 - 2) The hatch shall be provided with the following standard equipment:
 - (a) Stainless steel piano hinge, recessed lift handle, and staple for user-supplied padlock.
 - 4. Height
 - a. The manhole shall be 5 feet 0 inches high as measured from the inlet pipe invert to:
 - 1) Aluminum top style:
 - (a) Surface grade.
 - 5. Construction
 - a. One-piece construction.
- B. Materials of Construction
 - 1. Manhole
 - a. Fiberglass reinforced plastic laminate composed of:
 - 1) Unsaturated, single lot, isophthalic polyester resin with U.V. inhibitors
 - 2) E-glass reinforcement.

- 3) Chemically enhanced silica for improved corrosion resistance, strength, and overall performance.
 - 4) Wall thickness shall be sufficient to meet or exceed ASTM D3753.
 - b. Interior
 - 1) Smooth, resin rich, corrosion resistant to minimize sludge build-up.
 - 2) Naturally light tan with no added pigments to aid in the visual inspection of the manhole barrel laminate for resin odd-lotting and the inclusion of any voids, contaminants, etc.
 - 3) Free of exposed fibers, crazing, delamination, blisters larger than 1/2 inch, and wrinkles with a depth of 1/8 inch or greater.
 - 4) Pigments or gel coating of the interior manhole surface violated ASTM D3753 and are not allowed for any reason.
 - c. Exterior
 - 1) Gray 15 mil (cured) gel coat with U.V. inhibitors on all exterior surfaces.
 - 2) Patterned / rolled glass exterior surface with no exposed fibers, sharp projections, or blisters larger than 1/2 inch.
 - d. Sign
 - 1) A self-adhesive polyester "Confined Space Entry" sign on the manhole interior.
 - 2) Sign to comply with ANSI Z535.2 and 29 CFR 1910.145.
 - e. Coupling
 - 1) 2 inch FNPT fiberglass coupling for power, sampling, sensor, or other cabling laminated to the manhole barrel.
 - (a) Thru-wall fittings are not acceptable.
 - f. Ladder
 - 1) Stainless steel ladder support brackets thru-bolted and laminated outside to the manhole barrel.
 - 2) Ladder rungs
 - (a) Pultruded fiberglass 18 inches wide x 1 1/2 inches x 1/4 inch thick.
 - (b) Reinforced with 1/4 inch threaded stainless steel rod secured by solid pultruded fiberglass spacers.
 - (c) Spaced no more than 12 inches on center.
 - (d) Each rung shall have either an integrally molded non-slip surface or a full width, factory applied, coarse grit surface with a minimum dry coefficient of friction of 1.0.
 - (e) At the first ladder rung there shall be a fixed open cell grating platform to aid in entering / exiting the manhole (domed, aluminum hatch, and 48 inch manholes).
 - 3) All manholes with 36 inches or more of depth between the top of the flume and the top reference elevation of the manhole (manhole top – domed, hatch surround - aluminum hatch, reducer shoulder – H-20) shall be equipped with a factory installed ladder.
 - 4) Ladders shall meet 29 CFR 1910.27 for fixed ladders.
 - g. Base
 - 1) The manhole base shall be not less than 3/4 inch thick.
 - h. Mounting flange
 - 1) 4 inch wide x 3/4 inch thick integrally molded around the circumference of the manhole barrel for anchoring the manhole to the concrete pad.
 - i. Pad
 - 1) Customer to supply expanded polystyrene bead board for placement between the base of the manhole and the concrete slab.
2. Flume, end adapters, and pipe stubs
 - a. Fiberglass reinforced plastic laminate
 - 1) ISO certified polyester laminating resin:
 - (a) Low HAP.
 - (b) Properties shall meet or exceed:
 - (1) Tensile Strength ASTM D638 14,000 psi.
 - (2) Flexural Strength ASTM D790 22,000 psi.
 - (3) Flexural Modulus ASTM D790 900,000 psi.
 - (4) ANSI/AWWA F101 Type II.
 - (5) Water Absorption <0.15%.
 - (6) Allowable Defects ASTM D2563 Level I.

FIBERGLASS METERING MANHOLES

- 2) E-glass:
 - (a) Minimum of 30% of laminate content by weight.
 - (b) Silane coupling agent.
 - (c) C-glass shall not be allowed.
 - b. Gel coat:
 - 1) 15 mil cured thickness.
 - 2) U.V. inhibitors in all gel coat formulations, regardless of application or installation location.
 - 3) Interior Color: white gloss.
 - c. Covers:
 - 1) Integral fiberglass covers with a minimum total thickness of 1 1/4 inches over those portions of the flume or end adapters extending outside the manhole barrel to form a watertight structure capable of meeting the manhole burial depth.
- C. Flume Dimensional Tolerances:
- 1. Flume throat dimensions shall be plus or minus:
 - a. 1/16 inch for flume throat widths 12 inches or smaller.
 - b. 3/32 inch for flume throat widths greater than 12 inches.
 - 2. Other flume dimensions shall be plus or minus:
 - a. 1/8 inch for 24 inches or smaller.
 - b. 1/2 inch for flume dimensions 36 inches or larger.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that the manhole dimensions are correct and that the site conditions are suitable for installing the structure.

3.2 INSTALLATION

- A. The site must be of adequate size to accommodate the manhole and provide safe working room for the installing personnel.
- B. Do not allow groundwater or surface water runoff to accumulate in the open excavation.
- C. Provide a concrete foundation slab on which to mount / secure the manhole. The slab should extend a minimum of 12 inches on all sides beyond the manhole, base mounting flange, connecting pipes / flanges, and any structure integrated into the manhole.
- D. The thickness of the slab shall be a minimum of 6 inches, but as local soil conditions may vary, the final design of the slab and anchoring details are the responsibility of the installing party and must be sized so as to prevent shifting and flotation of the manhole structure.
- E. The concrete foundation slab shall have a smooth, troweled surface to provide uniform support over the entire base structure. The slab shall be level in both directions to within 1/8 inch and free from exposed aggregate and debris.
- F. Place the foam pad on the concrete slab where the manhole barrel will rest.
- G. Lower the manhole onto the concrete slab – taking particular care to secure the manhole from overturning during movement and lowering.
- H. Manholes supplied with pipe stubs may also be supplied with flexible couplings and stainless steel bands. Considerable force must be exerted by the coupling sealing surfaces during installation, if the coupling installs with little effort or appears loose, stop and contact the coupling manufacturer.
- I. Place the flexible couplings (when provided) on the manhole pipe stubs.

- J. Loosely secure the manhole to the concrete slab with anchor bolts (by others – wedge style recommended).
- K. Level the manhole so that the floor of the flume (the crest) is level from front-to-back and from side-to-side (using a level on the crest – not the top – of the flume).
- L. Once the flume level has been verified, complete the tightening of the anchor bolts to secure the manhole to the concrete slab.
- M. Complete the connection of the manhole to the inlet / outlet piping.

3.3 BACKFILLING

- A. Backfill should be placed evenly around the manhole in lifts of no more than 12 inches. Care should be taken to ensure that no void area exist between the concrete slab and any portion of the structure (i.e. under the flume, pipe connections, etc.).
- B. Fill material shall be imported sand or pea gravel material (naturally round aggregate 1/4-3/8 inch in size).
- C. If backfilling with another material avoid rocks, concrete, or soil lumps larger than 1 inch in size.

3.4 MANHOLE SHOULDER

- A. Inside the manhole there are void spaces between the interior of the manhole barrel and the exterior of the flume. These void spaces should be filled with supporting material to the top of the structure so that water does not collect. Sulfate resistant grout capping pea gravel or compacted sand is typical.
- B. The internal dimensions of the flume are critical to its proper operation. The flume must be braced internally with plywood and lumber during installation to ensure that distortion does not occur. The dimensional bracing on the top of the flume is provided to ensure dimensional accuracy. The bracing should be left on the flume until the installation has been completed.
- C. The finished surface or shoulder of grout should be even with the top of the flume and should be sloped towards the flume so that any overflow will drain back in to the flume.

3.5 ADJUST AND CLEAN

- A. Verify that the complete installation meets the criteria above and any additional criteria supplied by the Engineer.
- B. Clean the flow surfaces in accordance with the manufacturer's operation and maintenance instructions.
- C. Remove all trash and debris, leaving the site in a clean condition.

END OF SECTION

SECTION 33 14 16
WATER UTILITY DISTRIBUTION PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Water pipe for site conveyance lines.
- B. Pipe valves.
- C. DR11 HDPE Pipe and Fittings.
- D. Tracer Wire, Underground Warning tape.
- E. Pipe Supports.
- F. Joint Restraint Appurtenances.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.

1.3 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. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2022.
- D. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2019.
- E. AWWA C115/A21.15 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges; 2020.
- F. AWWA C500 - Metal-Seated Gate Valves for Water Supply Service; 2019.
- G. AWWA C509 - Resilient-Seated Gate Valves for Water Supply Service; 2023.
- H. AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances; 2023.
- I. AWWA C606 - Grooved and Shouldered Joints; 2022.
- J. AWWA C906 - AWWA Standard for Polyethylene (PE) Pressure Pipe and Fittings, 4 In. Through 63 In., for Water Distribution and Transmission.
- K. AWWA M55 - PE Pipe - Design and Installation, Second Edition; 2020.
- L. NSF 61 - Drinking Water System Components - Health Effects; 2024.
- M. ASTM D1784 - 11 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- N. ASTM D3261 - 10a Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Project Record Documents: Record actual locations of piping mains, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with municipality requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

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

PART 2 PRODUCTS

2.1 GENERAL

- A. Potable Water Supply Systems: All materials contacting potable water shall be certified compliant with NSF 61 for maximum lead content; label pipe and fittings.

2.2 WATER PIPE

- A. Copper Tubing: ASTM B88, Type K, Annealed:
 - 1. Fittings: ASME B16.18, cast copper, or ASME B16.22, wrought copper.
 - 2. Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- B. HDPE Pipe: AWWA M55
 - 1. Materials used for the manufacturing of polyethylene pipe and fittings shall be high density polyethylene (HDPE). The HDPE materials also shall be certified as suitable for potable water products by the National Sanitation Foundation (NSF) and AWWA (AWWA standard is C906). The material shall have a minimum hydrostatic design basis (HDB) of 1600 psi at 73° F.
 - 2. Pipe shall be manufactured in accordance with AWWA C-906. Pipe shall be furnished with squarely cut, plain ends in lengths that will allow for easy unloading, storage and installation. Nominal diameter, dimension ration, and pressure class shall be as shown on the contract drawings or herein specified.
 - 3. Permanent identification of piping service shall be provided by co-extruding blue material into the pipe's outside surface. The material used shall be the same material as the pipe except for color. Stripes printed or painted on the outside surface shall not be acceptable.
 - 4. Fittings shall conform to ASTM D3261 for butt-type and shall be molded or thermoformed from sections of pipe.
 - 5. All pipe lengths and fittings shall be joined by thermal butt-fusion in accordance with the manufacturer requirements. Mechanical joint fittings and HDPE/MJ adapters with internal stiffening ring shall join all connections to existing watermain and new appurtenances (HD C110 full body MJ gland, stiffener and stainless steel tee bolts). Nominal diameter and dimension ratio shall be as shown on the contract drawings.
 - 6. The pipe and fitting Manufacturer shall have an established quality control program responsible for inspecting incoming and outgoing materials. Incoming polyethylene materials shall be inspected for density, melt flow rate, and contamination. The cell classification properties of the material shall be certified by the supplier. Incoming materials shall be approved by Quality Control before processing into finished goods. Outgoing products shall be tested as required in AWWA C906.

7. The Manufacturer shall maintain permanent Quality Control (QC) and Quality Assurance (AQ) records. Certification or copy of these records shall be made available to the Engineer on request.

2.3 VALVES

- A. Gate Valves Up To 3 Inches:
 1. Brass or Bronze body, non-rising stem, inside screw, single wedge or disc, compression ends, with control rod, post indicator, valve key, and extension box.
- B. Gate Valves 3 Inches and Over:
 1. AWWA C509, ductile iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, stainless steel bonnet bolts, valve key, and extension box.

2.4 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 16.13.
- B. Cover: As specified in Section 31 23 16.13.

2.5 ACCESSORIES

- A. Concrete for Thrust Restraints: Concrete type specified in Section 03 30 00.

2.6 UNDERGROUND MARKING

- A. Underground markings shall comply with AWWA Uniform Color Code.
- B. Tracer Wire: Continuous 12 AWG, Solid, Copper clad high strength steel, with minimum 30 mil HDPE insulation, blue in color, suitable for direct burial.
- C. Warning Tape:
 1. Detectable Warning Tape: Magnetic detectable warning tape, 6 inches wide, 5 mil thick tape with aluminum backing, clear plastic covering, imprinted with "Water Service" in large black letters on blue background.

2.7 JOINT RESTRAINT APPURTENANCES

- A. M/J Joint Thrust Restraint Glands shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA C110 and have a working pressure rating of 350 psi.
- B. Push on Joint Thrust Restraint shall meet or exceed the performance criteria of U.S. Pipe Field Lok Gaskets, Gripper Gaskets, or Approved Equal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that building service connection and municipal utility water main size, location, and invert are as indicated.

3.2 PREPARATION

- A. Cut pipe ends square, ream pipe and tube ends to full pipe diameter, remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.

- C. Prepare pipe connections to equipment with flanges or unions.
- D. All PVC or Polyethylene Pipe shall not be left exposed to the sun and shall be covered. The contractor shall also provide documentation to the Construction Inspector as to the pipe's age and handling prior to being delivered to the site. This is to prevent pipe that has been left exposed to the sun at a storage yard from being used on the project. Lack of documentation of PVC or HDPE history will cause said pipe to be rejected.

3.3 BEDDING

- A. Place bedding material according to the trench details provided on the Engineering Drawings.
- B. Backfill around sides and to top of pipe with cover fill, tamp in place and compact to 95 percent.
- C. Tracer Wire:
 - 1. Install continuous length of tracer wire for the full length of each run of nonmetallic pipe.
 - 2. Attach wire to top of pipe securely to prevent displacement during installation.
- D. Place fill material in accordance with Section 31 23 23.

3.4 INSTALLATION - PIPE

- A. Maintain separation of water main from sewer piping in accordance with New York State DEC code.
- B. HDPE Pipe:
 - 1. The Manufacturer shall supply an Installation Manual to the Engineer which outlines guidelines for handling, joining, installing, embedding and testing of polyethylene pipeline. These guidelines shall be used as reference material for the Engineer in his determination of the required procedures.
 - 2. Joints between plain ends of polyethylene pipe shall be made by butt fusion when possible. The Pipe Manufacturer's fusion procedures shall be followed at all times as well as the recommendations of the Fusion Machine Manufacturer. The wall thickness of the adjoining pipes shall have the same DR at the point of fusion.
 - 3. If mechanical fittings (which are designed for, or tested and found acceptable for use with polyethylene pipe) are utilized for transitions between pipe materials, repairs, jointing pipe sections, saddle connections, or at other locations; the recommendation of the Mechanical Fitting Manufacturer must be followed. These procedures may differ from other pipe materials.
 - 4. Where connecting to newly laid ductile iron pipe, the next two ductile iron pipe joints adjacent to the HDPE/DIP connection shall utilize boltless restraining gaskets as approved by the engineer.
 - 5. On each day butt fusions are to be made, the first fusion of the day shall be a trial fusion.
The trial fusion shall be allowed to cool completely, then fusion test straps shall be cut out. The test strap shall be 12" or 30 times the wall thickness in length (minimum) and 1" or 1.5 times the wall thickness in width (minimum). Bend the test strap until the ends of the strap touch. If the fusion fails at the joint, a new trial fusion shall be made, cooled completely and tested. Butt fusion of pipe to be installed shall not commence until a trial fusion has passed the bent strap test.
 - 6. Pressure testing shall be conducted in accordance with the Manufacturer's recommended procedure. Pressure testing shall use water as the test media. Pneumatic (air) testing is prohibited.
 - 7. Consideration should be given by the Contractor that the length of the HDPE piping expands and contracts considerably with changes in temperature. As such, the Contractor should take appropriate measures to ensure that undue stresses do not occur with fused pipe and its associated fittings.
 - 8. The manufacturer shall have manufacturing and quality control facilities capable of producing and assuring the quality of the pipe and fittings required by these specifications and as shown on the contract drawings.

9. Caution shall be exercised at all times to avoid compression, damage or deformation to the pipe. Pipe shall be inspected before installation for cracks, defects, and chips and any pipe or fittings containing harmful imperfections shall be rejected and removed from the job site. HDPE pipe shall be supported by racks during storage to prevent damage to the bottom. Pipe stored outside shall be covered with opaque material while permitting air circulation around the pipe to prevent excessive heat accumulation. The interior as well as all sealing surfaces or pipe, fittings and other accessories shall be kept free from dirt and foreign matter. Severe impact blows, abrasion damage, and gouging or cutting by metal surfaces or rocks shall be avoided.

3.5 INSTALLATION - VALVES, HYDRANTS, BACKFLOW PREVENTERS

- A. Set valves on solid bearing.
- B. Center and plumb valve box over valve. Set box cover flush with finished grade.

3.6 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.
- B. Perform field inspection and testing in accordance with Section 01 40 00.
- C. Pressure test water piping:
 1. After completion of pipeline installation, including backfill, but prior to final connection to existing system, conduct, in presence of Architect/Engineer, concurrent hydrostatic pressure and leakage tests in accordance with AWWA C600.
 2. Provide equipment required to perform leakage and hydrostatic pressure tests.
 3. Test Pressure: Not less than 200 psi or 50 psi in excess of maximum static pressure, whichever is greater.
 4. Conduct hydrostatic test for at least two-hour duration.
 5. No pipeline installation will be approved when pressure varies by more than 5 psi at completion of hydrostatic pressure test.
 6. Before applying test pressure, completely expel air from section of piping under test. Provide corporation cocks so air can be expelled as pipeline is filled with water. After air has been expelled, close corporation cocks and apply test pressure. At conclusion of tests, remove corporation cocks removed and plug resulting piping openings.
 7. Slowly bring piping to test pressure and allow system to stabilize prior to conducting leakage test. Do not open or close valves at differential pressures above rated pressure.
 8. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damage or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
 9. No pipeline installation will be approved when leakage is greater than that determined by the following formula:

$$L = (S \cdot D \cdot \sqrt{P}) / 133,200$$

L = allowable leakage, in gallons per hour

S = length of pipe tested, in feet

D = nominal diameter of pipe, in inches

p = average test pressure during leakage test, in pounds per square inch (gauge)

10. When leakage exceeds specified acceptable rate, locate source and make repairs. Repeat test until specified leakage requirements are met.
- D. Perform backflow preventer testing in accordance with ASSE 5013, by State certified backflow prevention device tester.
 1. Provide test results and Certification of tester.
- E. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.

END OF SECTION

SECTION 33 31 13
SITE SANITARY SEWERAGE GRAVITY PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Sanitary sewerage drainage piping, fittings, and accessories.
- B. Connection of building sanitary drainage system to septic system.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation: Excavating of trenches.
- B. Section 31 23 23 - Fill: Bedding and backfilling.
- C. Section 33 05 61 - Concrete Manholes.

1.3 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.4 REFERENCE STANDARDS

- A. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- B. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2020.
- C. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2021.
- D. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2023.

1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Project Record Documents:
 - 1. Record location of pipe runs, connections, manholes, cleanouts, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 SEWER PIPE MATERIALS

- A. Provide products that comply with applicable code(s).
- B. Plastic Pipe: ASTM D2729, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4-15 inches, bell and spigot style solvent sealed joint end.
- C. Plastic Pipe: ASTM D3034, Type PSM, Poly(Vinyl Chloride) (PVC) material, SDR 35; inside nominal diameter of 4-15 inches, bell and spigot style neoprene gasket sealed joint end.
- D. Plastic Pipe: ASTM D1785, Schedule 40, Poly(Vinyl Chloride) (PVC) material; inside nominal diameter of 4-18 inches, bell and spigot style solvent sealed joint end.
- E. Joint Seals: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene ribbed gasket for positive seal.
- F. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.2 UNDERGROUND MARKING

- A. Underground markings shall comply with AWWA Uniform Color Code.
- B. Tracer Wire: Continuous 12 AWG, Solid, Copper clad high strength steel, with minimum 30 mil HDPE insulation, green in color, suitable for direct burial.
- C. Warning Tape:
 - 1. Detectable Warning Tape: Magnetic detectable warning tape, 6 inches wide, 5 mil thick tape with aluminum backing, clear plastic covering, imprinted with "Sewer Service" in large black letters on green background.

2.3 BEDDING AND COVER MATERIALS

- A. Pipe Bedding Material: As specified in Section 31 23 16.13.
- B. Pipe Cover Material: As specified in Section 31 23 16.13.

PART 3 EXECUTION

3.1 GENERAL

- A. Perform work in accordance with applicable code(s).

3.2 INSTALLATION - PIPE

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building sanitary sewer outlet , through installed sleeves.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing in accordance with Section 01 40 00.

- B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- C. Pressure Test
 - 1. Low-pressure Air Test (applies to all piping materials):
 - a. Test each section of gravity sewer piping between manholes.
 - b. Where customer service connections are installed under the Contract, test connections and service lines concurrently with the main, unless directed otherwise by the Engineer.
 - c. Introduce air pressure slowly to approximately 4 psig.
 - 1) Determine ground water elevation above spring line of pipe for every foot of ground water above spring line of pipe, increase starting air test pressure by 0.43 psig; do not increase pressure above 10 psig.
 - d. Allow pressure to stabilize for at least five minutes. Adjust pressure to 3.5 psig or increased test pressure as determined above when ground water is present. Start test.
 - e. Test:
 - 1) Determine test duration for sewer section with single pipe size from the following table. Do not make allowance for laterals.
 - 2) Record drop in pressure during test period; when air pressure has dropped more than 1.0 psig during test period, piping has failed; when 1.0 psig air pressure drop has not occurred during test period, discontinue test and piping is accepted.
 - 3) When piping fails, determine source of air leakage, make corrections and retest; test section in incremental stages until leaks are isolated; after leaks are repaired, retest entire section between manholes.
- D. Deflection Test (Applies to Plastic Sewer Pipe)
 - 1. Perform vertical ring deflection testing after backfilling has been in place for at least 30 days but not longer than 12 months.
 - 2. Allowable maximum deflection for installed plastic sewer pipe limited to 5 percent of original vertical internal diameter.
 - 3. Perform deflection testing using properly sized rigid ball or 'Go, No-Go' mandrel.
 - 4. Furnish rigid ball or mandrel with diameter not less than 95 percent of base or average inside diameter of pipe as determined by ASTM standard to which pipe is manufactured. Measure pipe in compliance with ASTM D2122.
 - 5. Perform test without mechanical pulling devices.
 - 6. Locate, excavate, replace and retest pipe exceeding allowable deflection.
- E. Lamp Test
 - 1. Lamp gravity piping after flushing and cleaning.
 - 2. Perform lamping operation by shining light at one end of each pipe section between manholes; observe light at other end; reject pipe not installed with uniform line and grade; remove and reinstall rejected pipe sections; re-clean and lamp until pipe section achieves uniform line and grade.

END OF SECTION

SECTION 33 34 13
SEPTIC TANKS

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation: General requirements for trenching for drainage field and connecting piping.
- B. Section 31 23 23 - Fill: General requirements for backfilling piping trenches including compaction testing.

1.2 REFERENCE STANDARDS

- A. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings; 2021.
- B. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping; 2020.

PART 2 PRODUCTS

2.1 SEPTIC TANK AND DISTRIBUTION BOX

- A. Manufacturers:
 - 1. Zieser Precast.
- B. Septic Tank: Reinforced precast concrete construction with 4,000 psi 28 day minimum strength, concrete partitioned chambers, concrete lid with lift rings, vent, inlet inspection hole, inlet turned down minimum 12 inches below effluent level.
- C. Tank Capacity: 2500 gallon.
- D. Distribution Box: Reinforced concrete, single inlet, two outlets, and single inlet, five outlets, gate, removable cover with lift ring, with speed leveler.

2.2 CONNECTING PIPE MATERIALS

- A. Cast Iron Pipe: ASTM A74 extra heavy grade, hub and spigot joint; nominal inside diameter of 4 inch:
- B. Plastic Pipe (ABS) : ASTM D2680, nominal inside diameter of 4 inch, bell and spigot solvent sealed joints.

2.3 FILTER DRAIN PIPE MATERIALS

- A. Use perforated pipe at filter field system; unperforated through sleeves and at junction with distribution box.

2.4 BEDDING AND BACKFILL MATERIALS

- A. Provide bedding and backfill materials as specified in Section 31 23 23 and as follows:
- B. Tank Bedding Material: Granular fill.
- C. Tank Backfill Material: Granular fill.

- D. Connecting Piping Bedding Material: Granular fill.
- E. Connecting Piping Backfill Material: Granular fill.
- F. Filter Drain Bedding Material: Fill type ASTM C33.
- G. Filter Drain Cover Material: Granular fill.
- H. Geotextile Fabric: Non-woven fabric, polypropylene, supplied by Eljen.

2.5 ACCESSORIES

- A. Septic Tank Effluent Filter
 - 1. Zabel A100 Cartridge Filter and Housing

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that building sanitary sewer connection, size, location and invert are as indicated.

3.2 EXCAVATING AND TRENCHING

- A. See Section 31 23 16 and Section 31 23 23 for general requirements.

3.3 TANK INSTALLATION

- A. Hand trim excavation for accurate placement of tank to elevations indicated.
- B. Place bedding material level in one continuous layer not exceeding 6 inches compacted depth, compact to 95 percent.
- C. Install septic tank and distribution box and related components on bedding in accordance with manufacturer's instructions.
- D. Backfill around sides of tank, tamped in place and compacted to 95 percent.

3.4 CONNECTING PIPING INSTALLATION

- A. Connect outlet between building sanitary piping and septic tank, between septic tank and distribution box, between distribution box and filter field header.
- B. Slope piping to each successive component, minimum of 1/4 inch per foot.
- C. Cover pipe with backfill, sides and top. Place geotextile fabric over cover prior to backfilling.

3.5 INSTALLATION - FILTER FIELD

- A. Place field pipe header sloping down from header inlet, 1/8 inch per foot.
- B. Place filter drain bedding 18 inch thick, tamp compact firm. Establish slope of bed to suit established invert elevations.
- C. Place pipe sloping away from header minimum of 1/16 inch per foot, with perforations facing down.
- D. Wrap pipe joints with paper, cover with filter drain bedding material, sides and top. Place geotextile fabric over cover prior to backfilling.

- E. Cover entire field with filter drain backfill material, 12 inch thick, lightly compacted; level for subsequent placement of soil cover.

3.6 PROTECTION

- A. Do not permit vehicular traffic over drainage field.

END OF SECTION

SECTION 33 41 16.16
GEOCOMPOSITE SUBDRAINAGE

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Subsurface Drainage Systems.
- B. Filter aggregate and bedding.

1.2 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation: Excavating for subdrainage system piping and surrounding filter aggregate.
- B. Section 31 23 23 - Fill: Backfilling over filter aggregate, up to subgrade elevation.
- C. Section 33 42 11 - Site Storm Utility Drainage Piping: Connector and drainage pipe.

1.3 REFERENCE STANDARDS

- A. ASTM D1621 - Standard Test Method for Compressive Properties of Rigid Cellular Plastics; 2016 (Reapproved 2023).
- B. ASTM D4355/D4355M - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc-Type Apparatus; 2021.
- C. ASTM D4491/D4491M - Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 2022.
- D. ASTM D4632/D4632M - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 2015a (Reapproved 2023).
- E. ASTM D4716/D4716M - Standard Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head; 2022.
- F. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2021a.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on geosynthetic drainage products, fittings, and accessories.
- C. Shop Drawings: Indicate dimensions, layout of geocomposite, high and low points of pipe inverts, and gradient of slope between corners and intersections.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Project Record Documents: Record location of geocomposite and pipe runs, connections, cleanouts and principal invert elevations.

PART 2 PRODUCTS

2.1 SUBSURFACE DRAINAGE

- A. Geocomposite Drainage: Structured high-density polyethylene (HDPE) perforated core, thermally bonded to geotextile filter fabric, suitable for horizontal or vertical installation. Drain shall allow water collection from all sides and provide continuous flow path.
 - 1. Drain Thickness: 1 inch, minimum.
 - 2. Drain Width: As indicated on Drawings..
 - 3. Core Material: High density polyethylene.
 - 4. Ultraviolet Stability: 70 percent, minimum, when tested in accordance with ASTM D4355/D4355M.
 - 5. Compressive Strength: 11,400 psi, minimum, when tested in accordance with ASTM D1621.
 - 6. Flow Rate: 21 gpm/ft width at 10psi and 0.1 gradient, minimum when tested in accordance with ASTM D4716/D4716M.
 - 7. Filter Fabric Material: Needle punctured, nonwoven geotextile.
 - 8. Elongation: 50%, minimum, when tested in accordance with ASTM D4632/D4632M
 - 9. Grab Tensile: 120 pounds, minimum, when tested in accordance with ASTM D4632/D4632M.
 - 10. Permittivity: 0.5 per second, minimum, ASTM D4491/D4491M.
 - 11. Apparent Opening Size: 70 U.S. Std. Sieve, in accordance with ASTM D4751.
 - 12. Products:
 - a. Intech Anchoring Systems; Hydraway: www.hydraway.net.
 - b. Or Approved Equal.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.

2.2 ACCESSORIES

- A. Drain Couplings, Fittings, and Outlets: Solid polypropylene plastic, same manufacturer as drain system.
- B. Connector and drainage pipe: See Section 33 42 11.

2.3 AGGREGATE AND BEDDING

- A. Filter Aggregate and Bedding Material: As detailed on Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that excavated base is ready to receive work and excavations, dimensions, and elevations are as indicated on drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over-excavation.
- B. Remove large stones or other hard matter that could damage geocomposite drainage piping or impede consistent backfilling or compaction.

3.3 INSTALLATION

- A. Install and join geocomposite system components and pipe fittings in accordance with drainage system manufacturer's instructions.
- B. Place drainage system on compacted granular fill.
- C. Lay geocomposite drain to slope gradients noted on drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
 - 1. For horizontal applications, ensure top and bottom of system is oriented according to manufacturer's instructions.

- D. Join geocomposite ends with manufacture's standard splice couplings.
- E. Install other fittings and outlet transitions at locations indicated on approved shop drawing to provide free flowing drainage.
- F. Place aggregate in maximum 4 inch lifts, consolidating each lift.
 - 1. Do not allow wheeled traffic over geocomposite prior to a minimum of 6 to 9 inches of compacted cover being established.
- G. Refer to Section 31 23 23 for compaction requirements. Do not displace or damage geocomposite or pipe when compacting.
- H. Connect to storm sewer system with unperforated pipe .

3.4 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements: Field inspection and testing.
- B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.5 PROTECTION

- A. Protect drainage, pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

SECTION 33 42 11
SITE STORM UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Stormwater drainage piping.
- B. Stormwater pipe accessories.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete: Concrete for cleanout base pad construction.
- B. Section 31 23 16 - Excavation: Excavating of trenches.
- C. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- D. Section 31 23 23 - Fill: Bedding and backfilling.
- E. Section 33 05 61 - Concrete Manholes.
- F. Section 33 42 30 - Stormwater Drains.

1.3 REFERENCE STANDARDS

- A. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe; 2020.
- B. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2022a.
- C. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120; 2021a.
- D. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2020.

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe, pipe accessories.
- C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- D. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- E. Project Record Documents:
 - 1. Record location of pipe runs, connections, and invert elevations.
 - 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 PRODUCTS

2.1 STORMWATER PIPE MATERIALS

- A. Plastic Pipe: ASTM D2729, Poly Vinyl Chloride (PVC) material; inside nominal diameter of 4-15 inches, bell and spigot style solvent sealed joint end.
- B. Plastic Pipe: ASTM D3350, High Density Polyethylene (HDPE) corrugated wall pipe with integrally formed smooth liner; inside nominal diameter of 3 - 60 inch, meeting the requirements of AASHTO M 252, Type S, for diameters between 3 inches and 10 inches and AASHTO M 294, Type S, for diameters between 12 inches and 60 inches, soil-tight, bell and spigot joints with rubber gaskets, with pipe and fittings manufactured from virgin PE compounds with cell classification 3254420C, or better.

2.2 PIPE ACCESSORIES

- A. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.
- B. Filter Fabric: Non-biodegradable, woven.
- C. Trace Wire: Magnetic detectable conductor, clear plastic covering, minimum 6 inches wide by 4 mil thick, imprinted with "Storm Sewer Service " in large letters, for direct burial service.

2.3 BEDDING AND COVER MATERIALS

- A. Bedding: As specified in Section 31 23 16.13.
- B. Cover: As specified in Section 31 23 16.13.

PART 3 EXECUTION

3.1 TRENCHING

- A. See Section 31 23 16.13 - Trenching for additional requirements.
- B. Hand trim excavation for accurate placement of pipe to elevations indicated.
- C. Backfill around sides and to top of pipe with cover fill, tamp in place and compact, then complete backfilling to provide top cover to minimum compacted thickness of 12 inches exclusive of asphalt or concrete, compacted to 95%.

3.2 INSTALLATION

- A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout drawings.
- B. Install pipe, fittings, and accessories in accordance with manufacturer's instructions. Seal watertight.
 - 1. Plastic Pipe: Also comply with ASTM D2321.
- C. Lay pipe to slope gradients noted on layout drawings; with maximum variation from true slope of 1/8 inch in 10 feet.
- D. Connect to building storm drainage system, foundation drainage system, and utility/municipal system.
- E. Make connections through walls through sleeved openings, where provided.
- F. Install continuous trace wire 6 inches above top of pipe; coordinate with Section 31 23 16.13.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection in accordance with Section 01 40 00 - Quality Requirements.

3.4 PROTECTION

- A. Protect pipe and bedding cover from damage or displacement until backfilling operation is in progress.
- B. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION

SECTION 33 42 30
STORMWATER DRAINS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Precast concrete catch basins.
- B. Prefabricated drop inlets.
- C. Prefabricated trench drains.
- D. Frames and grates.

1.2 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 31 23 16 - Excavation.
- C. Section 31 23 23 - Fill.
- D. Section 33 42 11 - Site Storm Utility Drainage Piping.

1.3 REFERENCE STANDARDS

- A. AASHTO HB - Standard Specifications for Highway Bridges; 2005, with Errata.
- B. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- C. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- D. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- E. ASTM C478/C478M - Standard Specification for Circular Precast Reinforced Concrete Manhole Sections; 2020.
- F. ASTM C990 - Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants; 2009 (Reapproved 2019).

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Weight rating for catch basins, drop inlets, trench drains, and frame and grates.
- C. Shop Drawings: Indicate stack assembly, invert elevations, opening sizes, and pipe angles.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least three years of documented experience.
- B. Installer Qualifications: Company specializing in installing work of the type specified in this section, and with at least three years of documented experience and approved by manufacturer.
- C. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.

PART 2 PRODUCTS

2.1 CATCH BASINS

- A. Weight Rating: H 10 according to AASHTO HB.
- B. Precast Concrete Catch Basins: Comply with ASTM C478/C478M, reinforced.
 - 1. Wall Thickness: 6 inches (152 mm).
 - 2. Base Thickness: 12 inches (305 mm).
 - 3. Reinforcement: Formed steel wire, galvanized finish, wire diameter as indicated on drawings.
 - 4. Joint Sealant: Comply with ASTM C990.
- C. Cast-In-Place Concrete Materials: See Section 03 30 00.
- D. Grade Adjustments:
 - 1. Adjustment Ring: Expanded polypropylene, 6 inches (152 mm) wide, diameter matching frame dimensions, in accordance with ASTM C478/C478M.
- E. Frames and Grates: Cast iron, checkerboard pattern.

2.2 DROP INLETS

- A. Weight Rating: H 10 according to AASHTO HB.
- B. Prefabricated Drop Inlet: Polymer concrete, glass fiber reinforced, metal installation brackets.
- C. Frames and Grates: Galvanized steel support, cast iron grate, checkerboard pattern, match drain opening size.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify items provided by other sections of work are properly sized and located.
- B. Verify built-in items are in proper location and ready for roughing into work.
- C. Verify excavation location and depth are correct.

3.2 EXCAVATION AND FILL

- A. Hand trim excavation for accurate placement to indicated elevations.
- B. Backfill with cover fill, tamp in place and compact, then complete backfilling.

3.3 INSTALLATION

- A. Establish elevations and pipe inverts for inlets and outlets as indicated in drawings.
- B. Precast Concrete Catch Basins:

1. Place base section plumb and level.
 2. Install joint sealant uniformly around section lip.
- C. Prefabricated Drop Inlets or Trench Drains:
1. Place base section plumb and level.
 2. Install according to manufacturer's instructions.
 3. Secure installation brackets.
- D. Grade Adjustments:
1. Install expanded polypropylene ring according to manufacturer's instructions.
 2. Place adjacent materials tight and smooth following design grades.
- E. Frames and Grates:
1. Place frame plumb and level.
 2. Mount frame on expanded polypropylene ring according to manufacturer's instructions.
 3. Mount frame on prefabricated drop inlets or trench drains according to manufacturer's instructions.
 4. Place grate in frame securely.

3.4 FIELD QUALITY CONTROL

- A. See Section 01 40 00 - Quality Requirements for additional requirements.
- B. Perform field inspection for pipe invert elevations.
- C. If inspections indicate work does not meet specified requirements, adjust work and reinspect at no cost to Owner.

END OF SECTION

SECTION 33 48 00
SUBSURFACE RETENTION SYSTEMS

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Section 31 23 16 - Excavation: Excavating of trenches.
- B. Section 31 23 16.13 - Trenching: Excavating, bedding, and backfilling.
- C. Section 31 23 23 - Fill: Bedding and backfilling.

1.2 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.3 REFERENCE STANDARDS

- A. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications; 2020.
- B. ASTM F2648 - Standard Specification for High Density Polyethylene (HDPE) Sewer Pipe and fittings having smooth interior

1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating pipe and pipe accessories .
- C. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- D. Design Calculations: Demonstrate that proposed products meet the required sizing and structural loading requirements, including a load resistance factor design and creep analysis. Calculations to confirm structural adequacy shall be provided to the engineer's satisfaction.
- E. Shop Drawings: Contractor shall submit detailed drawings, showing proposed system layout, dimensions, elevations, cross section and materials.
- F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. ADS Advanced Drainage Systems, Stormtech; www.ads-pipe.com.
- B. Lane Enterprises, Stormkeeper: www.lane-enterprises.com.
- C. ACO, Storm Brixx; www.acostormbrixx.com.

2.2 MATERIALS

- A. Materials shall be suitable to support the required loading conditions and to maintain longevity with frequent contact with stormwater flows.
- B. Storm Chambers or Pipes: Series of chambers or pipes consisting of corrugated high density polyethylene, polypropylene, or similar material placed within a stone bed.
- C. Bedding Stone: 3/4" to 2" clean washed crushed angular stone.
- D. Non-Woven Geotextile: AASHTO M288 Class 2 Non-Woven Geotextile Fabric such as a Mirafi 160N or approved equal. Non-Woven Geotextile is to be used as a separation layer between the bedding stone and fill to prevent fines intrusion and as a filter layer over the sediment separator chamber or pipe to prevent fines from migrating out of the chamber during flow events.
- E. Woven Geotextile: AASHTO M288 Class 1 Woven Geotextile Fabric such as a Mirafi 600X or approved equal. Woven Geotextile is to be used as a stabilization layer below the sediment separator chamber or pipe to prevent scouring of stone during cleaning and at each inlet row to prevent scouring during storm events.

2.3 PERFORMANCE

- A. Capacity: System shall provide the minimum volume as stated on the contract documents.
- B. Footprint: System shall provide the minimum footprint as stated on the contract documents.
- C. Structural Loading Capacity: System shall be suitable for surface loading conditions and soil bearing above system, including creep.
- D. Sediment separator: System shall provide a means of trapping sediment in water quality flow situations and allow for maintenance of this row to ensure longevity of the system.
- E. High Flow Conditions: System shall be provided with a header system to allow for high flow situations to be distributed across the infiltration area.
- F. Bedding: System shall be provided with a minimum of six (6) inches of stone bedding material above and below the storage devices. This is to be included in the maximum system depth as shown in the contract documents. Stone bedding material shall be provided between the chambers or pipes in accordance with the manufacturers recommendations but not less than six (6) inches.

2.4 QUALITY ASSURANCE

- A. The manufacturer of the subsurface stormwater retention system shall be one that is regularly engaged in the engineering design and production of stormwater systems deployed for the management of storm water runoff for at least five (5) years and which have a history of successful production, acceptable to the Engineer.
- B. Training
 - 1. The Contractor and Manufacturer shall provide on-site training for the Owner's Facility Personnel.
 - 2. The training shall include information and hands-on instruction regarding the installation, operation, and maintenance of the system and its components.

PART 3 EXECUTION

3.1 HANDLING AND STORAGE

- A. The contractor shall exercise care in the storage and handling of the retention system components prior to and during installation. Any repair or replacement costs associated with events occurring after delivery is accepted and unloading has commenced shall be born by the contractor.

3.2 INSTALLATION

- A. The subsurface system shall be installed in accordance with the manufacturer's recommendations and related sections of the contract documents. The manufacturer shall provide the contractor installation instructions and offer on-site guidance during the important stages of the installation as identified by the manufacturer at no additional expense. A minimum of 72 hours notice shall be provided to the manufacturer prior to their performance of the services included under this subsection.

END OF SECTION