

Project Manual For:

**Haines Maintenance and Operations Station
Project No. Z571830000**



Volume 2 of 2

**State of Alaska
Department of Transportation and Public Facilities
Central Region
4111 Aviation Avenue, Anchorage, Alaska 99502**

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SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Non-load-bearing steel framing systems for interior gypsum board assemblies.
 - 2. Suspension systems for interior gypsum ceilings, soffits, and grid systems.
- B. Related Requirements:
 - 1. Division 09 Section "Gypsum Board" for finishing of stud framed interior gypsum soffits.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
 - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 (Z120), hot-dip galvanized unless otherwise indicated.
- C. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) ClarkDietrich Building Systems.
 - 2) Fire Trak Corp.
 - 3) Metal-Lite.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 1. Minimum Base-Metal Thickness: 0.027 inch (0.68 mm).
- E. Cold-Rolled Channel Bridging: Steel, 0.053-inch (1.34-mm) minimum base-metal thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: 1-1/2 inches (38 mm).
 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches (38 by 38 mm), 0.068-inch- (1.72-mm-) thick, galvanized steel.

2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.
- B. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.
- C. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
 1. Depth: 2 inches (51 mm) unless indicated otherwise.
- D. Furring Channels (Furring Members):
 1. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
 2. Steel Studs and Runners: ASTM C 645.
 - a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
 - b. Depth: 3 5/8-inches or 6-inches unless indicated otherwise.
 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
 - a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
- E. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Armstrong World Industries, Inc.
 - b. United States Gypsum Company.

2.4 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- B. Isolation Strip at Exterior Walls: Provide one of the following:
 1. Asphalt-Saturated Organic Felt: ASTM D 226, Type I (No. 15 asphalt felt), nonperforated.
 2. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
 1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
 2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
 - 2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
 - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
 - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - a. Install two studs at each jamb unless otherwise indicated.
 - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
 - c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
 - 3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
 - 4. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
- E. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

3.5 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
 - 1. Hangers: 48 inches (1219 mm) o.c.
 - 2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
 - 3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 4. Do not attach hangers to steel roof deck.
 5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
 7. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- E. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION

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SECTION 09 29 00 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Interior gypsum board.
 - 2. Tile backing panels.
- B. Related Requirements:
 - 1. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
 - 2. Division 09 Section "Porcelain Tile" for cementitious backer units installed as substrates for porcelain wall tile.

1.3 ACTION SUBMITTALS

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

1.4 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. CertainTeed Corporation.
 - 2. Georgia-Pacific Building Products.
 - 3. United States Gypsum Company.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Thickness: 5/8 inch (15.9 mm).
 - 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 - 1. Thickness: 1/2 inch (12.7 mm).
 - 2. Long Edges: Tapered.
- D. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: 5/8 inch (15.9 mm), Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CertainTeed Corporation.
 - b. James Hardie Building Products, Inc.
 - c. United States Gypsum Company.
 - 2. Thickness: 5/8 inch (15.9 mm).

3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. Expansion (control) joint.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping drying-type, all-purpose compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.7 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.

1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

C. Sound Attenuation Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.

- D. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Pecora Corporation.
 - b. United States Gypsum Company.
 - 2. Acoustical joint sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Thermal Insulation and Vapor Retarder: As specified in Division 07 Section "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Type X: Vertical surfaces unless otherwise indicated.
 - 2. Ceiling Type: Ceiling surfaces.
 - 3. Moisture- and Mold-Resistant Type: As indicated on Drawings.
 - 4. Type C: Where required for specific fire-resistance-rated assembly indicated.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
 - 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

3.4 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile.

- B. Water-Resistant Backing Board: Install where indicated with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- C. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
 - 1. Cornerbead: Use at outside corners unless otherwise indicated.
 - 2. LC-Bead: Use at exposed panel edges.
 - 3. L-Bead: Use where indicated.

3.6 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 4: Smooth finish at panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Division 09 Section "Interior Painting."
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

HAINES MAINTENANCE AND OPERATIONS STATION
PROJECT NO. Z571830000

SECTION 09 29 00
GYPSUM BOARD

END OF SECTION 092900

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SECTION 09 30 13 - PORCELAIN TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Porcelain tile.
- B. Related Requirements:
 - 1. Section 079200 "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
 - 2. Section 092900 "Gypsum Board" for cementitious backer units.

1.3 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Module Size: Actual tile size plus joint width indicated.
- C. Face Size: Actual tile size, excluding spacer lugs.

1.4 PREINSTALLATION MEETINGS

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Installer is a five-star member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
 2. Installer's supervisor for Project holds the International Masonry Institute's Foreman Certification.
 3. Installer employs Ceramic Tile Education Foundation Certified Installers or installers recognized by the U.S. Department of Labor as Journeyman Tile Layers.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type from single source or producer.
 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
 1. Provide tile complying with Standard grade requirements unless otherwise indicated.

- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

2.3 TILE PRODUCTS

- A. Ceramic Tile Type: Unglazed porcelain tile.
 - 1. Basis of Design Product:
 - a. Argent Porcelain Stone as manufactured by Crossville.
 - 2. Certification: Tile certified by the Porcelain Tile Certification Agency.
 - 3. Face Size: 3 by 3 inches, and 6 by 6 inches where indicated on the drawings.
 - 4. Face Size Variation: Rectified.
 - 5. Thickness: 1/4 inch.
 - 6. Face: Plain with square edges.
 - 7. Dynamic Coefficient of Friction: Not less than 0.42.
 - 8. Tile Color, Glaze, and Pattern: As indicated by manufacturer's designations.
 - 9. Grout Color: As selected by Architect from manufacturer's full range.
 - 10. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base Cap: Surface bullnose, module size same as adjoining flat tile.
 - b. Wainscot Cap: Surface bullnose, module size same as adjoining flat tile.
 - c. External Corners: Surface bullnose, module size.
 - d. Internal Corners: Inside radius units..

2.4 SETTING MATERIALS

- A. Latex-Portland Cement Mortar (Thinset): ANSI A118.4.
 - 1. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
 - 2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

- A. Sand-Portland Cement Grout: ANSI A108.10, consisting of white or gray cement and white or colored aggregate as required to produce color indicated.
- B. Grout for PregROUTed Tile Sheets: Same product used in factory to pregROUT tile sheets.

2.6 MISCELLANEOUS MATERIALS

- A. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

- B. Grout Sealer: Manufacturer's standard product for sealing grout joints and that does not change color or appearance of grout.
 - 1. Grout sealers shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Small-Scale Environmental Chambers."

2.7 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
 - 2. Verify that concrete substrates for tile floors installed with thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
 - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- B. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

3.3 CERAMIC TILE INSTALLATION

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
 - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
 - a. Tile floors consisting of tiles 8 by 8 inches or larger.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
 - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
 - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
 - 1. Porcelain Tile: 1/4 inch.
- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Grout Sealer: Apply grout sealer to cementitious grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3.6 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

3.7 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations, Concrete Subfloor:
 - 1. Ceramic Tile Installation: TCNA F113; thinset mortar.
 - a. Ceramic Tile Type: Porcelain Tile.
 - b. Thinset Mortar: Latex- portland cement mortar.
 - c. Grout: Standard sanded cement grout.
- B. Interior Wall Installations, Wood or Metal Studs or Furring:
 - 1. Ceramic Tile Installation: TCNA W244C or TCNA W244F; thinset mortar on cementitious backer units.
 - a. Ceramic Tile Type: Porcelain tile.
 - b. Thinset Mortar: Latex- portland cement mortar.
 - c. Grout: Standard sanded cement grout.

END OF SECTION

SECTION 09 51 23 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Acoustical tiles for ceilings.
 - 2. Concealed suspension systems.
- B. Related Requirements:
 - 1. Division 9 Sections "Non-Structural Metal Framing" and "Gypsum Board" for gypsum board ceilings and soffits.
- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For components with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Ceiling suspension-system members.
 - 2. Method of attaching hangers to building structure.
 - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. All items that penetrate the finished ceiling, including:
 - a. Lighting fixtures
 - b. Air outlets and inlets
 - c. Speakers
 - d. Sprinklers
 - e. Access panels

5. Perimeter moldings.
6. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical tiles, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical tiles, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical tiles carefully to avoid chipping edges or damaging units in any way.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical tile ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical tile ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
 2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL TILES, GENERAL

- A. Low-Emitting Materials: Acoustical tile ceilings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Source Limitations:
 1. Acoustical Ceiling Tile: Obtain each type from single source from single manufacturer.
 2. Suspension System: Obtain each type from single source from single manufacturer.

- C. Source Limitations: Obtain each type of acoustical ceiling tile and supporting suspension system from single source from single manufacturer.
- D. Acoustical Tile Standard: Provide manufacturer's standard tiles of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.
- E. Acoustical Tile Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical tiles are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL TILES (See designations on Drawings)

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Calla #2821 smooth texture acoustical ceiling tiles as manufactured by Armstrong World Industries, Inc. or comparable product by another manufacturer.
- B. Classification: Provide tiles complying with ASTM E 1264 for type, form, and pattern as follows:
 - 1. Type and Form: Type IV, mineral base with painted finish; Form 2, water felted.
 - 2. Pattern: As indicated by manufacturer's designation.
- C. Location: All corridors and rooms within the scope of the Work unless specifically noted otherwise on the Drawings.
- D. Color: White.
- E. NRC: Not less than 0.70.
- F. CAC: Not less than 35.
- G. Edge/Joint Detail: 15/16" Square lay-in.
- H. Thickness: 3/4 inch (19 mm).
- I. Modular Size: As indicated on Drawings.
- J. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical tiles treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Metal Suspension-System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.
- B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire.
- D. Seismic Restraint System: Manufacturer's standard system of struts, clips and other devices for "floating" installation in compliance with ASCE 7-10 and the International Building Code.

2.5 ACOUSTICAL SEALANT

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 1. Acoustical Sealant for Exposed and Concealed Joints:
 - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
 - b. USG Corporation; SHEETROCK Acoustical Sealant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing and substrates to which acoustical tile ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine acoustical tiles before installation. Reject acoustical tiles that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Testing Substrates: Before installing adhesively applied tiles on wet-placed substrates such as cast-in-place concrete or plaster, test and verify that moisture level is below tile manufacturer's recommended limits.
- B. Measure each ceiling area and establish layout of acoustical tiles to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width tiles at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION OF SUSPENDED ACOUSTICAL TILE CEILINGS

- A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 4. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
 6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
 7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
 8. Do not attach hangers to steel deck tabs.
 9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 10. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
 11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical tile ceiling area and where necessary to conceal edges of acoustical tiles.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
 2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
 3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Arrange directionally patterned acoustical tiles as follows:
1. As indicated on reflected ceiling plans.
- G. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension-system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
 2. Hold tile field in compression by inserting leaf-type, spring-steel spacers between tile and moldings, spaced 12 inches (305 mm) o.c.
 3. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

- A. Clean exposed surfaces of acoustical tile ceilings, including trim and edge moldings. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace tiles and other ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Resilient base.
 - 2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches (300 mm) long.
- C. Product Schedule: For resilient base and accessory products.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.5 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Low-Emitting Materials: Flooring system shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.2 THERMOSET-RUBBER BASE (See Drawings for designation)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Burke Mercer Flooring Products; a division of Burke Industries Inc.
 - 2. Flexco.
 - 3. Roppe Corporation, USA.
- B. Product Standard: ASTM F 1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
 - 1. Style and Location:
 - a. Style B, Cove: Where indicated on Drawings.
- C. Thickness: 0.125 inch (3.2 mm).
- D. Height: 4 inches (102 mm).
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Job formed or preformed.
- G. Inside Corners: Job formed.
- H. Colors: As indicated by manufacturer's designations in a finish schedule.

2.3 RUBBER MOLDING ACCESSORY (See Drawings for designation)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Roppe Corporation, USA.
 - 2. Flexco.
 - 3. VPI Corporation.
- B. Description: Rubber reducer strip for resilient flooring and transition strips.
- C. Profile and Dimensions: As indicated.
- D. Locations: Provide rubber molding accessories in areas indicated.
- E. Colors and Patterns: As indicated by manufacturer's designations in a finish schedule.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
 - 1. Adhesives shall have a VOC content of 50 g/L or less.
 - 2. Adhesives shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
 - 1. Outside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - a. Form without producing discoloration (whitening) at bends.
 - 2. Inside Corners: Use straight pieces of maximum lengths possible and form with returns not less than 3 inches (76 mm) in length.
 - a. Miter or cope corners to minimize open joints.

3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum horizontal surfaces thoroughly.
 - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Luxury vinyl floor tile.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: Full-size units of each color and pattern of floor tile required.
- C. Samples for Initial Selection: For each type of floor tile indicated.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store floor tiles on flat surfaces.

1.6 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

2.2 LUXURY VINYL FLOOR TILE (see drawings for designation)

1. Basis of Design Product: Per finish schedule.
2. Tile Standard: ASTM F 1700, Class III, printed film vinyl tile.
3. Wearing Surface: Type A, Smooth.
4. Thickness: 0.098 inches.
5. Tile Size: 23-5/8 x 23-5/8 inches.
6. Colors and Patterns: As indicated by manufacturer's designations
7. Installation: Glue-down.
8. Wear Layer: 30 mil
9. Underlayment: Provide acoustical underlayment as indicated below.
10. Finish: ExoGuard Quartz Enhanced Urethane.
11. Slip Resistance: ADA Compliant
12. Residual Indentaion: ASTM F970, 2000 psi.
13. Flexibility/ASTM F 137 Passes, 6mm
14. Dimensional Stability/ASTM F 2199 <0.02"/ft., Passes
15. Resistance to Heat/ASTM F 1514 Passes
16. Resistance to Light/ASTM F 1515 Passes
17. Resistance to Chemicals/ASTM F 925 Passes
18. Radiant Flux/ASTM E 648 >0.45 watts/cm², NFPA Class I
19. Smoke Density/ASTM E 662 <450, Passes

2.3 UNDERLAYMENT

- A. For products noted above requiring acoustical underlayment, provide as follows:
- B. Basis of design Product: Patcraft, Hush II, Acoustical Underlayment
1. Thickness: 0.098 inches
 2. Sound Transmission class: 56 per ASTM E90/E413.
 3. Impact Insulation Class: 51 per ASTM E492/E989

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.
 - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
 - 2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
 - 3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 pH.
 - 4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install floor tiles until they are the same temperature as the space where they are to be installed.
 - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles in pattern indicated.
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles in pattern of colors and sizes indicated.

- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- H. Install acoustical underlayment in accordance with the manufacturer's recommendations and as required to provide flush surfaces between tiles of varying thicknesses.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
 - 1. Apply three coat(s).
- E. Cover floor tile until Substantial Completion.

END OF SECTION

SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following exterior substrates:
 - 1. Concrete.
 - 2. Steel.
 - 3. Galvanized metal.
- B. Related Requirements:
 - 1. Division 05 Section "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.
 - 2. Division 09 Section "High-Performance Coatings" for special-use coatings.
 - 3. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.
 - 4. Division 09 Section "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on exterior wood substrates.

1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.

4. Label each Sample for location and application area.

C. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Benjamin Moore & Co.
 2. Dulux (formerly ICI Paints); a brand of AkzoNobel.
 3. Dunn-Edwards Corporation.
 4. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Provide materials that comply with VOC limits of authorities having jurisdiction.
- D. Colors: As indicated in a color schedule.

2.3 PRIMERS/SEALERS

- A. Primer, Alkali Resistant, Water Based: MPI #3.

2.4 METAL PRIMERS

- A. Primer, Alkyd, Anti-Corrosive for Metal: MPI #79.

2.5 WATER-BASED PAINTS

- A. Latex, Exterior Flat (Gloss Level 1): MPI #10.
- B. Light Industrial Coating, Exterior, Water Based (Gloss Level 3): MPI #161.

2.6 SOLVENT-BASED PAINTS

- A. Alkyd, Exterior Flat (Gloss Level 1): MPI #8.

2.7 FLOOR COATINGS

- A. Sealer, Water Based, for Concrete Floors: MPI #99.

2.8 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 2. Testing agency will perform tests for compliance with product requirements.
 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- E. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
- F. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.

2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
 3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
 4. Paint entire exposed surface of window frames and sashes.
 5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
1. Paint the following work where exposed to view:
 - a. Equipment, including panelboards and switch gear.
 - b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
 - 1. Latex System:
 - a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
 - b. Intermediate Coat: Latex, exterior, matching topcoat.
 - c. Topcoat: Latex, exterior flat (Gloss Level 1), MPI #10.
- B. Concrete Substrates, Traffic Surfaces:
 - 1. Water-Based Clear Sealer System:
 - a. Prime Coat: Sealer, water based, for concrete floors, MPI #99.
 - b. Intermediate Coat: Sealer, water based, for concrete floors, MPI #99.
 - c. Topcoat: Sealer, water based, for concrete floors, MPI #99.
- C. Steel Substrates:
 - 1. Alkyd System:
 - a. Prime Coat: Primer, alkyd, anticorrosive for metal, MPI #79.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Alkyd, exterior, flat (Gloss Level 1), MPI #8.
- D. Galvanized-Metal Substrates:
 - 1. Water-Based Light Industrial Coating System:
 - a. Prime Coat: Primer, galvanized metal, as recommended in writing by topcoat manufacturer for exterior use on galvanized-metal substrates with topcoat indicated.
 - b. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
 - c. Topcoat: Light industrial coating, exterior, water based (Gloss Level 3), MPI #161.

END OF SECTION

SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and the application of paint systems on the following interior substrates:
 - 1. Concrete.
 - 2. Steel.
 - 3. Galvanized metal.
 - 4. Wood.
 - 5. Gypsum board.
 - 6. Cotton or canvas insulation covering.
 - 7. ASJ insulation covering.
- B. Related Requirements:
 - 1. Division 05 Section "Structural Steel Framing" for shop priming of metal substrates with primers specified in this Section.
 - 2. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.
 - 3. Division 09 Section "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates, including wood trim and plywood wainscoting at maintenance bays.
 - 4. Division 09 Section "High Performance Coating" for epoxy floor system at washbay.

1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.
- D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.
- C. Product List: For each product indicated, include the following:
 - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
 - 3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Behr Process Corporation.
 - 2. Benjamin Moore & Co.
 - 3. Dunn-Edwards Corporation.
 - 4. Rodda Paint Co.
 - 5. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.
- D. Colors: As indicated in a color schedule.

2.3 PRIMERS/SEALERS

- A. Primer Sealer, Latex, Interior: MPI #50.
- B. Primer, Latex, for Interior Wood: MPI #39.

2.4 METAL PRIMERS

- A. Primer, Alkyd, Anti-Corrosive, for Metal: MPI #79.
- B. Primer, Alkyd, Quick Dry, for Metal: MPI #76.
- C. Primer, Galvanized, Water Based: MPI #134.

2.5 WATER-BASED PAINTS

- A. Latex, Interior, Flat, (Gloss Level 1): MPI #53.
- B. Latex, Interior, (Gloss Level 4): MPI #43.

2.6 FLOOR COATINGS

- A. Sealer, Water Based, for Concrete Floors: MPI #99.

2.7 SOURCE QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials

from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - 1. Concrete: 12 percent.
 - 2. Masonry (Clay and CMU): 12 percent.
 - 3. Wood: 15 percent.
 - 4. Gypsum Board: 12 percent.
 - 5. Plaster: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Plaster Substrates: Verify that plaster is fully cured.
- E. Spray-Textured Ceiling Substrates: Verify that surfaces are dry.
- F. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- G. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 - 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

- E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer's written instructions.
- F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer but not less than the following:
 - 1. SSPC-SP 2, "Hand Tool Cleaning."
 - 2. SSPC-SP 3, "Power Tool Cleaning."
- G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- I. Wood Substrates:
 - 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 - 2. Sand surfaces that will be exposed to view, and dust off.
 - 3. Prime edges, ends, faces, undersides, and backsides of wood.
 - 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- J. Cotton or Canvas Insulation Covering Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
 - 1. Use applicators and techniques suited for paint and substrate indicated.
 - 2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 - 3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 - 4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
 - 5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
 - 1. Paint the following work where exposed in equipment rooms or occupied spaces:
 - a. Equipment, including panelboards and switch gear.

- b. Uninsulated metal piping.
 - c. Uninsulated plastic piping.
 - d. Pipe hangers and supports.
 - e. Metal conduit.
 - f. Plastic conduit.
 - g. Tanks that do not have factory-applied final finishes.
 - h. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
2. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
 1. Contractor shall touch up and restore painted surfaces damaged by testing.
 2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

- A. Concrete Substrates, Nontraffic Surfaces:
 1. Latex System:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
- B. Concrete Substrates, Traffic Surfaces:
 1. Water-Based Clear Sealer System:
 - a. First Coat: Sealer, water based, for concrete floors, MPI #99.
 - b. Topcoat: Sealer, water based, for concrete floors, MPI #99.

- C. Steel Substrates:
 - 1. Latex over Alkyd Primer System:
 - a. Prime Coat: Primer, alkyd, anti-corrosive, for metal, MPI #79 or primer, alkyd, quick dry, for metal, MPI #76.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.
- D. Galvanized-Metal Substrates:
 - 1. Latex over Waterborne Primer System:
 - a. Prime Coat: Primer, galvanized, water based, MPI #134.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
- E. Wood Substrates: Including wood trim wood-based panel products.
 - 1. Latex System:
 - a. Prime Coat: Primer, latex, for interior wood, MPI #39.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
- F. Gypsum Board Substrates:
 - 1. Latex System:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Prime Coat: Latex, interior, matching topcoat.
 - c. Intermediate Coat: Latex, interior, matching topcoat.
 - d. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.
- G. Cotton or Canvas and ASJ Insulation-Covering Substrates: Including pipe and duct coverings.
 - 1. Latex System:
 - a. Prime Coat: Primer sealer, latex, interior, MPI #50.
 - b. Intermediate Coat: Latex, interior, matching topcoat.
 - c. Topcoat: Latex, interior, flat, (Gloss Level 1), MPI #53.

END OF SECTION

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SECTION 099300 - STAINING AND TRANSPARENT FINISHING

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and application of wood finishes on the following substrates:
 - 1. Interior Substrates:
 - a. Dressed lumber (finish carpentry).
- B. Related Requirements:
 - 1. Division 09 Section "Exterior Painting" for standard paint systems on exterior substrates.

1.3 DEFINITIONS

- A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.
- B. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
- C. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.
- D. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- E. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.
- B. Samples for Initial Selection: For each type of product indicated.
- C. Samples for Verification: For each type of finish system and in each color and gloss of finish indicated.
 - 1. Submit Samples on representative samples of actual wood substrates, 8 inches square.
 - 2. Label each Sample for location and application area.
- D. Product List: For each product indicated, include the following:
 - 1. Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules.
 - 2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the product proposed for use highlighted.
 - 3. VOC content.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
 - 1. Maintain containers in clean condition, free of foreign materials and residue.

2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

- A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply finishes when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior finishes in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, manufacturers with available products that may be incorporated into the Work include, but are not limited to the following.
 1. Behr Process Corporation Benjamin Moore & Co articles to require specific pDulux (formerly ICI Paints); a brand of AkzoNobel Glidden Professional Parker Paint; Comex Group Pratt & Lambert Rodda Paint Co Sherwin-Williams Company (The)

2.2 MATERIALS, GENERAL

- A. MMPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
- B. Material Compatibility:
 1. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.
 1. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
- D. Low-Emitting Materials: Interior stains and finishes shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.3 WOOD FILLERS

- A. Wood Filler Paste: MPI #91.

2.4 POLYURETHANE VARNISHES

- A. Varnish, Interior, Polyurethane, Oil-Modified, Satin (Gloss Level 4): MPI #57.

2.5 SOURCE QUALITY CONTROL

- A. Testing of Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample wood finishing materials. Contractor will be notified in advance and may be present when samples are taken. If materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Owner may direct Contractor to stop applying wood finishes if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces before refinishing with complying materials if the two finishes are incompatible or produce results that, in the opinion of the Architect, are aesthetically unacceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- B. Maximum Moisture Content of Interior Wood Substrates: 10 percent, when measured with an electronic moisture meter.
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Proceed with finish application only after unsatisfactory conditions have been corrected.
 1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.
 1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.
 1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.
- D. Interior Wood Substrates:
 1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
 2. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
 3. Sand surfaces that will be exposed to view and dust off.
 4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

- A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 - 1. Use applicators and techniques suited for finish and substrate indicated.
 - 2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
 - 3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, or other surface imperfections.

3.4 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

- A. Wood substrates, nontraffic surfaces, including wood trim and architectural woodwork.
 - 1. Polyurethane Varnish System:
 - a. Prime Coat: Polyurethane varnish matching topcoat.
 - b. Intermediate Coat: Polyurethane varnish matching topcoat.
 - c. Topcoat: Varnish, interior, polyurethane, oil-modified, satin (Gloss Level 4), MPI #57.

END OF SECTION

SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes surface preparation and application of high-performance coating systems on the following substrates:
 - 1. Interior Substrates:
 - a. Concrete, horizontal surfaces at washbay.
 - b. Steel, exposed structure at washbay exterior wall.
- B. Related Requirements:
 - 1. Division 09 Section "Interior Painting" for general field painting.

1.3 DEFINITIONS

- A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
- B. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.
- B. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.
 - 1. Submit Samples on rigid backing, 8 inches (200 mm) square.
 - 2. Step coats on Samples to show each coat required for system.
 - 3. Label each coat of each Sample.
 - 4. Label each Sample for location and application area.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Coatings: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
 - 1. Maintain containers in clean condition, free of foreign materials and residue.
 - 2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

- A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.
- C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Behr Process Corporation.
 - 2. Benjamin Moore & Co.
 - 3. Cloverdale Paint.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

- A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."
- B. Material Compatibility:
 - 1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
 - 2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
 - 3. Provide products of same manufacturer for each coat in a coating system.
- C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction.
- D. Colors: As indicated in color schedule.

2.3 METAL PRIMERS

- A. Primer, Zinc-Rich, Epoxy: MPI #20.

2.4 POLYURETHANE COATINGS

- A. Polyurethane, Two-Component, Pigmented, Gloss (Gloss Level 6): MPI #72.

2.5 EPOXY COATINGS

- A. Epoxy, High-Build, Low Gloss: MPI #108.
 - 1. Bar-Rust 235 multi-purpose epoxy coating as manufactured by Devoe High Performance Coatings, or an approved equal product from another manufacturer.

2.6 SOURCE QUALITY CONTROL

- A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:
 - 1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
 - 2. Testing agency will perform tests for compliance with product requirements.
 - 3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
 - 1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
 - a. Concrete: 12 percent.
- B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- C. Proceed with coating application only after unsatisfactory conditions have been corrected.
 - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.
- C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
 1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
 1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm).

3.3 APPLICATION

- A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
 1. Use applicators and techniques suited for coating and substrate indicated.
 2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
 3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
 4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.
- D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

- A. Dry Film Thickness Testing: Owner will engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
 1. Contractor shall touch up and restore coated surfaces damaged by testing.
 2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

- A. Concrete Substrates, Horizontal Surfaces.
 - 1. Pigmented Polyurethane System:
 - a. Prime Coat: Epoxy, as recommended in writing by topcoat manufacturer.
 - b. Intermediate Coat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
 - c. Topcoat: Polyurethane, two-component, pigmented, gloss (Gloss Level 6), MPI #72.
- B. Steel Substrates:
 - 1. High-Build Epoxy System:
 - a. Prime Coat: Primer, zinc-rich, epoxy, MPI #20.
 - b. Intermediate Coat: Epoxy, high-build, low gloss, MPI #108.
 - c. Topcoat: Epoxy, high-build, low gloss, MPI #108.

END OF SECTION

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SECTION 101100 - VISUAL DISPLAY UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Markerboards.
 - 2. Display rails.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
 - 2. Include electrical characteristics for motorized units.
- B. Shop Drawings: For visual display units.
 - 1. Include plans, elevations, sections, details, and attachment to other work.
 - 2. Show locations of panel joints.
 - 3. Show locations and layout of special-purpose graphics.
 - 4. Include sections of typical trim members.
- C. Samples for Verification: For each type of visual display unit indicated.
 - 1. Visual Display Panel: Not less than 8-1/2 by 11 inches (215 by 280 mm), with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
 - 2. Trim: 6-inch- (150-mm-) long sections of each trim profile.
 - 3. Display Rail: 6-inch- (150-mm-) long section of each type.
 - 4. Rail Support System: 6-inch- (152-mm-) long sections.
 - 5. Accessories: Full-size Sample of each type of accessory.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for surface-burning characteristics of tackboards.
- C. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For visual display units to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display units by field measurements before fabrication.
 - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

1.10 WARRANTY

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Surfaces lose original writing and erasing qualities.
 - b. Surfaces exhibit crazing, cracking, or flaking.
 - 2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of visual display unit from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

2.3 VISUAL DISPLAY BOARD ASSEMBLY

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. A-1 Visual Systems.
 2. AARCO Products, Inc.
 3. Best-Rite; MooreCo, Inc.
 4. Claridge Products and Equipment, Inc.
 5. Ghent Manufacturing, Inc.
 6. Marsh Industries, Inc.
- B. Visual Display Board Assembly: factory fabricated.
1. Assembly: markerboard
 2. Corners: Square.
 3. Width: As indicated on Drawings.
 4. Height: As indicated on Drawings.
 5. Mounting Method: Direct to wall.
- C. Markerboard Panel: Porcelain-enamel-faced markerboard panel on core indicated.
1. Color: White.
- D. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch- (1.57-mm-) thick, extruded aluminum; standard size and shape.
1. Aluminum Finish: Clear anodic finish.
- E. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
- F. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.

2.4 DISPLAY RAILS (TACK RAILS)

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. AARCO Products, Inc.
 2. Best-Rite; MooreCo, Inc.
 3. Claridge Products and Equipment, Inc.
 4. Ghent Manufacturing, Inc.
 5. Marsh Industries, Inc.
- B. Aluminum Display Rail: Manufacturer's standard, extruded-aluminum display rail with plastic-impregnated-cork tackable insert, and continuous paper holder, designed to hold accessories.
- C. Paper Holder Display Rail: Extruded aluminum; designed to hold paper by clamping action.
1. Aluminum Finish: Clear anodic finish.
- D. Tackable Insert Color: As selected by Architect from full range of industry colors.
- E. Size: 2 inches (50 mm) high by length indicated on Drawings.

- F. End Stops: Aluminum.
- G. Accessories:
 - 1. Metal Map Hooks: Include two map hooks per 48 inches of installed display rail.

2.5 MARKERBOARD PANELS

- A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with low-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
 - 1. Face Sheet Thickness: 0.021 inch (0.53 mm) uncoated base metal thickness.
 - 2. Manufacturer's Standard Core: Minimum 1/4 inch (6 mm) thick, with manufacturer's standard moisture-barrier backing.
 - 3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

2.6 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Hardboard: ANSI A135.4, tempered.
- C. Fiberboard: ASTM C 208 cellulosic fiber insulating board.
- D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063.

2.7 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.

3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
 - 1. Mounting Height: As indicated on the Drawings, or 36 inches above finished floor to bottom or marker board or tack board.
- B. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches (400 mm) o.c. Secure tops and bottoms of boards to walls.
- C. Display Rails: Install rails at mounting heights indicated on Drawings, or if not indicated, at height indicated below. Attach to wall surface with fasteners at not more than 16 inches (400 mm) o.c.
 - 1. Mounting Height: 84 inches (2134 mm) above finished floor to top of rail.

3.4 CLEANING AND PROTECTION

- A. Clean visual display units according to manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION

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SECTION 10 14 53 - TRAFFIC SIGNAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Division 01 Specification Sections, apply to this Section.
- B. Alaska Department of Transportation and Public Facilities (ADOT&PF), Standard Specifications for Highway Construction, 2015 Edition.

1.02 SUMMARY

- A. The WORK under this Section includes providing all labor, materials, tools, and equipment necessary for installing sign assemblies and bollards as shown on the Drawings.

1.03 REFERENCES

- A. ASTM International:
 - 1. ASTM A53 – Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. ASTM C94 – Specification for Ready-Mixed Concrete.
 - 3. ASTM D746 – Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - 4. ASTM D790 – Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
 - 5. ASTM D4956 - Specification for Retroreflective Sheeting for Traffic Control.
 - 6. ASTM F2329 – Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screw, Washers, Nuts, and Special Threaded Fasteners.

1.04 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Product Data:
 - 1. Sign Posts.
 - 2. Bollard Pipe.
 - 3. Bollard Paint.
 - 4. Bollard Cover.
 - 5. Bollard Concrete and Forms.
 - 6. Traffic Paint and Application Requirements.
- C. Manufacturer's Certificate: Certify the following products meet or exceed specified requirements.
 - 1. Sign Materials.
 - 2. Traffic Paint.

PART 2 - PRODUCTS

2.01 REGULATORY SIGNS

- A. Provide signs with legend and Manual on Uniform Traffic Control Devices (MUTCD) regulatory sign designation shown in the drawings. Background, border and legend dimensions and colors follow MUTCD sign designation unless noted otherwise.

2.02 SIGN MATERIALS

- A. Sign Panels - All sign panels shall be sheet aluminum meeting material and fabrication requirements of ADOT&PF Specification Section, 730-2.01 Sheet Aluminum. Sheet thickness of 0.125 inches unless otherwise specified.
- B. Retroreflective Sheeting - All signs shall have retroreflective sheeting on the sign blank meeting ASTM D4956, Type III or IV retroreflective, Class 1 adhesive.
- C. Sign Posts - Provide perforated steel tube posts meeting material and fabrication requirements of ADOT&PF Specification Section, 730-2.04, paragraph 2. Perforated Steel Posts. Posts shall be manufactured such that consecutive sizes will telescope freely with minimum of play.
- D. Hardware - Sign and post hardware shall be either aluminum alloy, 18-8 or 304 grade stainless steel, or ASTM F2329 hot-dip zinc coated carbon steel.

2.03 BOLLARDS

- A. Bollard Pipe - Bollard pipe shall be Schedule 40, ASTM A53, factory galvanized steel pipe. Diameters as shown on the Drawings.
- B. Bollard Paint - Bollard top coat paint shall be a single component, polyurethane modified alkyd, gloss finish formulated for marine and offshore conditions. Prime coat galvanized steel pipe after solvent cleaning the pipe surface following Society for Protective Coatings (SSPC) procedure SP-1. Solvent used for cleaning shall be compatible with the prime coat. Two (2) top coats. Color: MUTCD Yellow-116 or equivalent.
- C. Bollard Cover - Bollard cover shall be UV-stabilized HDPE material, minimum 0.125 inch thick, ASTM D790 flexural modulus of 200,000 psi, ASTM D746 brittleness temperature of -180 degrees F. Factory provided cover shall be long enough for field trimming to match bollard height. Color: MUTCD Yellow-116 or equivalent.
- D. Round Concrete Form – Round concrete forms consist of multiple layers of paperboard, spirally wound, and laminated with adhesive. Exterior surface manufactured with a moisture barrier.
- E. Bollard Concrete – Provide concrete conforming to ASTM C94, with at least 5.0 sacks of Type 1 cement per cubic yard of concrete and obtaining a minimum 28-day compressive strength of 3,000 psi. Bagged concrete mix or redi-mix concrete is acceptable.

2.04 TRAFFIC PAINT

- A. Provided traffic paint meeting the requirements of ADOT&PF Specification Section 708 PAINTS, Article 708-2.03 PAINT FOR TRAFFIC MARKINGS, acrylic emulsion.

PART 3 - EXECUTION

3.01 GENERAL

- A. Sign assemblies and bollards shall be installed at locations shown on the Drawings. Install signs at right angles to the direction of, and facing, the traffic intended to be served.

- B. Provide driven sign post base section with a suitable driving head provided by the manufacturer. Provide pilot holes as needed for installing the base section plumb. An augured post hole backfilled with concrete can be used in place of a driven post.
- C. Where concrete backfill is used provide backstop to prevent concrete from filling the steel anchor base steel tube interior and preventing inserting of the sign post.

3.02 ADOT&PF ROAD TRAFFIC MARKINGS

- A. Furnish and place traffic markings in accordance with ADOT&PF Specification Section 670 TRAFFIC MARKINGS, Article 670-3.01 CONSTRUCTION REQUIREMENTS.
 - 1. Delete glass beads.
 - 2. Include paint manufacturer's application requirements as part of CONSTRUCTION REQUIREMENTS.

END OF SECTION

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SECTION 102600 - WALL PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Corner guards.
- B. Related Requirements:
 - 1. Division 06 Section "Rough Carpentry" and 09 Section "Gypsum Board" for wall finishes at corridors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, impact strength, dimensions of individual components and profiles, and finishes.
 - 2. Include fire ratings of units recessed in fire-rated walls and listings for door-protection items attached to fire-rated doors.
- B. Shop Drawings: For each type of wall and door protection showing locations and extent.
 - 1. Include plans, elevations, sections, and attachment details.
- C. Samples for Verification: For each type of exposed finish on the following products, prepared on Samples of size indicated below:
 - 1. Corner Guards: 12 inches (300 mm) long. Include example top caps.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of handrail.
- B. Material Certificates: For each type of exposed plastic material.
- C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of wall and door protection product to include in maintenance manuals.
 - 1. Include recommended methods and frequency of maintenance for maintaining best condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to finishes and performance.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store wall and door protection in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
 - 1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
 - a. Store corner-guard covers in a vertical position.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of wall- and door-protection units that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including detachment of components from each other or from the substrates, delamination, and permanent deformation beyond normal use.
 - b. Deterioration of metals, metal finishes, plastics, and other materials beyond normal use.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain wall- and door-protection products from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Surface Burning Characteristics: Comply with ASTM E 84 or UL 723; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 450 or less.
- B. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1.

2.3 CORNER GUARDS

- A. Surface-Mounted, Metal Corner Guards: Fabricated as one piece from formed or extruded metal with formed edges; with 90- or 135-degree turn to match wall condition.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide stainless steel corner guards by Korogard Wall Protection Systems; a division of RJF International Corporation; or a comparable product by one of the following:
 - a. Babcock-Davis.
 - b. InPro Corporation (IPC).
 - c. JL Industries, Inc.; a division of the Activar Construction Products Group.

- d. Nystrom, Inc.
- 2. Material: Stainless-steel sheet, Type 304.
 - a. Thickness: Minimum 0.0625 inch (1.6 mm).
 - b. Finish: Directional satin, No. 4.
- 3. Wing Size: Nominal 3-1/2 by 3-1/2 inches (90 by 90 mm).
- 4. Corner Radius: 1/4 inch
- 5. Mounting: Flat-head, countersunk screws through factory-drilled mounting holes.
 - a. Profile: Nominal 3-inch- (75-mm-) long leg and 1-1/4-inch (32-mm) corner radius.
 - b. Height: 4 feet (1.2 m).
 - c. Color and Texture: As indicated by manufacturer's designations.
- 6. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.

2.4 MATERIALS

- A. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- B. Adhesive: As recommended by protection-product manufacturer and with a VOC content of 70 g/L or less.

2.5 FABRICATION

- A. Fabricate wall and door protection according to requirements indicated for design, performance, dimensions, and member sizes, including thicknesses of components.
- B. Factory Assembly: Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Quality: Fabricate components with uniformly tight seams and joints and with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

2.6 FINISHES

- A. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine walls to which wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing wall and door protection.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. Installation Quality: Install wall and door protection according to manufacturer's written instructions, level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
- B. Accessories: Provide splices, mounting hardware, anchors, trim, joint moldings, and other accessories required for a complete installation.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard ammonia-based household cleaning agent.
- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION

SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Public-use washroom accessories.
 - 2. Public-use shower room accessories.
 - 3. Underlavatory guards.
 - 4. Custodial accessories.
- B. Related Sections:
 - 1. Division 08 Section "Mirrors".

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include the following:
 - 1. Construction details and dimensions.
 - 2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
 - 3. Material and finish descriptions.
 - 4. Features that will be included for Project.
 - 5. Manufacturer's warranty.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
 - 1. Identify locations using room designations indicated.
 - 2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.8 WARRANTY

- A. Special Mirror Warranty: Manufacturer's standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.
- D. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bobrick Washroom Equipment, Inc.
 - 2. Bradley Corporation.
- B. Toilet Tissue (Roll) Dispenser:

1. Basis-of-Design Product: Model B-288 Classic Series Surface-Mounted Multi-Roll Toilet Tissue Dispenser as manufactured by Bobrick Washroom Equipment, Inc.
 2. Description: Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
 3. Mounting: Surface mounted.
 4. Capacity: Designed for 5-inch- (127-mm-) diameter tissue rolls.
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- C. Combination Towel (Roll) Dispenser/Waste Receptacle:
1. Basis-of-Design Product: Model B-3942 Semi-recessed convertible paper towel dispenser and waste receptacle as manufactured by Bobrick Washroom Equipment, Inc.
 2. Description: Combination unit for dispensing preset length of roll paper towels, with removable waste receptacle.
 3. Mounting: Semi-recessed.
 4. Minimum Towel-Dispenser Capacity: 600 C-fold or 800 multi-fold paper towels.
 5. Minimum Waste Receptacle Capacity: 12 gal. (45.4 L).
 6. Material and Finish: Stainless steel, No. 4 finish (satin).
 7. Liner: Reusable, vinyl waste-receptacle liner.
 8. Lockset: Tumbler type for towel dispenser compartment.
- D. Waste Receptacle:
1. Basis-of-Design Product: Model B-43644 Recessed waste receptacle as manufactured by Bobrick Washroom Equipment, Inc.
 2. Description: Recessed waste receptacle with removable front panel and trash liner holder.
 3. Mounting: Recessed.
 4. Minimum Waste Receptacle Capacity: 12 gal. (45.4 L).
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
 6. Liner: Reusable, vinyl waste-receptacle liner.
 7. Lockset: Tumbler type for towel dispenser compartment.
- E. Liquid-Soap Dispenser:
1. Basis-of-Design Product: B-40 Classic Series Surface Mounted Soap Dispenser as manufactured by Bobrick Washroom Equipment, Inc.
 2. Description: Designed for dispensing soap in liquid or lotion form.
 3. Mounting: Horizontally oriented, surface mounted.
 4. Capacity: 40.0 oz. (1.2L).
 5. Materials: Black, translucent ABS container with grey, high-impact resistant ABS lid and wall bracket.
 6. Valve: Grey, high-impact resistant ABS push button and spout.
- F. Grab Bar:
1. Basis-of-Design Product: Models B-5806x42, B-5806x36, B-5806x12.
 2. Mounting: Flanges with concealed fasteners.
 3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
 - a. Finish: Smooth, No. 4 finish (satin) on ends and slip-resistant texture in grip area.
 4. Outside Diameter: 1-1/2 inches (38 mm).
 5. Configuration and Length: Straight, 12 inches, 36 inches and 42 inches long.
- G. Vendor:
1. Basis-of-Design Product: B-37063C Trimline Series Recessed Napkin/ Tampon No Coin Vendor as manufactured by Bobrick Washroom Equipment, Inc.
 2. Type: Sanitary napkin and tampon.
 3. Mounting: Fully recessed, designed for 4-inch (100-mm) wall depth.
 4. Capacity: 20 napkins and 30 tampons.
 5. Operation: No coin (free).
 6. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).

7. Lockset: Tumbler type with separate lock and key for coin box.
- H. Sanitary-Napkin Disposal Unit: B-254 Surface Mount Sanitary Napkin Disposal Receptacle as manufactured by Bobrick Washroom Equipment, Inc.
 1. Basis-of-Design Product: B-254 Surface Mount Sanitary Napkin Disposal Receptacle as manufactured by Bobrick Washroom Equipment, Inc
 2. Mounting: Surface mounted.
 3. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
 4. Receptacle: Removable.
 5. Material and Finish: Stainless steel, No. 4 finish (satin).
- I. Seat-Cover Dispenser:
 1. Basis-of-Design Product: B-221 Classic Series Surface Mounted Seat Cover Dispenser.
 2. Mounting: Surface mounted.
 3. Minimum Capacity: 500 seat covers.
 4. Exposed Material and Finish: Stainless steel, No. 4 finish (satin).
 5. Lockset: Tumbler type.
- J. Mirror Unit: See Division 08 Section "Mirrors".

2.3 PUBLIC-USE SHOWER ROOM ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Bobrick Washroom Equipment, Inc.
 2. Bradley Corporation.
- B. Shower Curtain Rod:
 1. Basis-of-Design Product: B-207x36 Shower Curtain Rod as manufactured by Bobrick Washroom Equipment, Inc.
 2. Description: 1-inch (25.4-mm) OD; fabricated from nominal 0.0375-inch- (0.95-mm-) thick stainless steel.
 3. Mounting Flanges: Stainless-steel flanges designed for concealed fasteners.
 4. Finish: No. 4 (satin).
- C. Shower Curtain:
 1. Basis-of-Design Product: B-204-2 Shower Curtain as manufactured by Bobrick Washroom Equipment, Inc.
 2. Size: Minimum 6 inches (152 mm) wider than opening by 72 inches (1828 mm) high.
 3. Material: Nylon-reinforced vinyl, minimum 10 oz. (284 g) or 0.008-inch- (0.2-mm-) thick vinyl, with integral antibacterial agent.
 4. Color: White.
 5. Grommets: Corrosion resistant at minimum 6 inches (152 mm) o.c. through top hem.
 6. Shower Curtain Hooks: Chrome-plated or stainless-steel, spring wire curtain hooks with snap fasteners, sized to accommodate specified curtain rod. Provide one hook per curtain grommet.
- D. Folding Shower Seat:
 1. Basis-of-Design Product: B-517 or B-518 Folding Shower Seat with Padded Cushion as manufactured by Bobrick Washroom Equipment, Inc.
 2. Configuration: L-shaped seat, designed for wheelchair access.
 3. Seat: 2" thick, closed-cell polyurethane foam padding mounted on ½" thick plywood covered in white water resistant reinforced vinyl fabric.
 4. Mounting Mechanism: Stainless steel, No. 4 finish (satin).
- E. Soap Dish:

1. Basis-of-Design Product: B-680 Surface-mounted soap dish as manufactured by Bobrick Washroom Equipment, Inc.
2. Description: Without washcloth bar.
3. Mounting: Surface mounted.
4. Material and Finish: Stainless steel, No. 4 finish (satin).

F. Robe Hook:

1. Basis-of-Design Product: B-671 Single robe hook as manufactured by Bobrick Washroom Equipment, Inc..
2. Description: Single-prong unit.
3. Material and Finish: Stainless steel, No. 4 finish (satin).

2.4 UNDERLAVATORY GUARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Plumberex Specialty Products, Inc.
 2. Truebro by IPS Corporation.
- B. Underlavatory Guard:
1. Basis-of-Design Product: Lav Shield lavatory protective enclosure as manufactured by Truebro.
 2. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
 3. Material and Finish: Antimicrobial, molded plastic, white.

2.5 CUSTODIAL ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Bobrick Washroom Equipment, Inc.
 2. Bradley Corporation.
- B. Utility Shelf:
1. Basis-of-Design Product: B-295 x 16 Stainless Steel Shelf as manufactured by Bobrick Washroom Equipment, Inc.
 2. Description: With exposed edges turned down not less than 1/2 inch (13 mm) and supported by two triangular brackets welded to shelf underside.
 3. Size: 16 inches (406 mm) long by 6 inches (152 mm) deep.
 4. Material and Finish: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel, No. 4 finish (satin).
- C. Mop and Broom Holder:
1. Basis-of-Design Product: B-223x36 Mop and Broom Holder.
 2. Description: Unit with shelf, hooks, holders, and rod suspended beneath shelf.
 3. Length: 36 inches (914 mm).
 4. Hooks: Three.
 5. Mop/Broom Holders: Four, spring-loaded, rubber hat, cam type.
 6. Material and Finish: Stainless steel, No. 4 finish (satin).
 - a. Shelf: Not less than nominal 0.05-inch- (1.3-mm-) thick stainless steel.
 - b. Rod: Approximately 1/4-inch- (6-mm-) diameter stainless steel.

2.6 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.
- B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.

3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION

SECTION 104413 - FIRE PROTECTION CABINETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-protection cabinets at offices.
 - 2. Mounting brackets for fire extinguishers at maintenance bays and storage areas.
 - 3. Portable fire extinguishers
- B. Related Requirements:
 - 1. Division 09 Section "Gypsum Board" for typical interior wall finish at cabinet locations.

1.3 PREINSTALLATION CONFERENCE

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to fire-protection cabinets and fire extinguishers including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed-, semirecessed-, or surface-mounting method and relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Product Schedule: For fire-protection cabinets and fire extinguishers. Indicate whether cabinets are recessed, semirecessed, or surface mounted. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-protection cabinets and fire extinguishers to include in maintenance manuals.

1.6 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- D. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet indicated.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Amerex Corporation.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.
 - 2. Valves: Manufacturer's standard.
 - 3. Handles and Levers: Stainless steel.
 - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb (4.5-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.3 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - b. Larsens Manufacturing Company.
 - c. Nystrom, Inc.
- B. Cabinet Construction: Nonrated.
- C. Cabinet Material: Aluminum sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- D. Semirecessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - 1. Rolled-Edge Trim: 2-1/2-inch (64-mm) backbend depth.
- E. Cabinet Trim Material: Aluminum sheet.
- F. Door Material: Aluminum sheet.
- G. Door Style: Fully glazed panel with frame.
- H. Door Glazing: Tempered float glass (clear).
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting door pull and friction latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- J. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 - 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
 - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER."
 - 1) Location: Applied to cabinet door or cabinet glazing.
 - 2) Application Process: Manufacturer's standard.
 - 3) Lettering Color: Red.
 - 4) Orientation: Vertical.
- K. Materials:
 - 1. Cold-Rolled Steel: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
 - 2. Aluminum: ASTM B 221 (ASTM B 221M), with strength and durability characteristics of not less than Alloy 6063-T5 for aluminum sheet. ASTM B 221 (ASTM B 221M) for extruded shapes.
 - a. Finish: Clear anodic.

3. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.4 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Amerex Corporation.
 - b. JL Industries, Inc.; a division of the Activar Construction Products Group.
 - c. Larsens Manufacturing Company.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Vertical.

2.5 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth.
 2. Provide factory-drilled mounting holes.
 3. Prepare doors and frames to receive locks.
 4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.6 GENERAL CABINET FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
 - 1. Unless otherwise indicated, provide semirecessed fire-protection cabinets. Coordinate depth of recess with wall thickness required.
 - 2. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- C. Wall Mounted Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.
- D. Identification: Apply decals at locations indicated.
- E. Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.

- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Welded lockers.
 - 2. Locker benches.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of metal locker.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.
- B. Shop Drawings: For metal lockers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Show locker trim and accessories.
 - 3. Include locker identification system and numbering sequence.
- C. Samples for Verification: For the following products, in manufacturer's standard size:
 - 1. Lockers and equipment.
 - 2. Locker benches.
- D. Product Schedule: For lockers.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.
- B. Deliver master and control keys to Owner by registered mail or overnight package service.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.
 - 2. Damage from deliberate destruction and vandalism is excluded.
 - 3. Warranty Period for Welded Metal Lockers: Lifetime from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single locker manufacturer.
 - 1. Obtain locks from single lock manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1.

2.3 WELDED LOCKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Lyon Workspace Products, LLC; Heavy Duty All-Welded Lockers or a comparable product by one of the following:
 - 1. Penco Products, Inc.
 - 2. Republic Storage Systems, LLC.

- B. Locker Dimensions: 12 inches wide by 15 inches deep by 72 inches high single tier locker.
- C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 - 1. Tops and Bottoms: 0.060-inch (1.52-mm) nominal thickness, with single bend at edges.
 - 2. Backs: 0.048-inch (1.21-mm) nominal thickness.
 - 3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.
- D. Unperforated Sides: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- E. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet or 0.097-inch (2.45-mm) nominal-thickness steel angles; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
 - 1. Cross Frames for Lockers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.
- F. Reinforced Bottoms: Structural channels, formed from 0.060-inch (1.52-mm) nominal-thickness steel sheet; welded to front and rear of side-panel frames.
- G. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
 - 1. Continuous Hinges: Manufacturer's standard, steel; side or top mounted as required by locker configuration.
- H. Door Handle and Latch for Box Lockers: Stainless-steel strike plate with integral pull; with steel padlock loop that projects through metal locker door.
- I. Locks: Combination padlocks.
- J. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
- K. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- L. Coat Rods: Manufacturer's standard.
- M. Legs: 6 inches (152 mm) high; formed by extending vertical frame members, or fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; welded to bottom of locker.
 - 1. Closed Front and End Bases: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- N. Continuous Sloping Tops: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.
 - 1. Closures: Vertical-end type.
- O. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- P. Boxed End Panels: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet.
- Q. Materials:

1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- R. Finish: Baked enamel or powder coat.
 1. Color: Men's Lockers - 3005-5F 'Wine Red', Women's Lockers - 'Forest Green' 66.

2.4 LOCKS

- A. Combination Padlocks: Provided by Owner.

2.5 LOCKER BENCHES

- A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).
- B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
 1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick (241 mm wide by 32 mm thick) except provide minimum 20-inch- (508-mm-) wide tops where accessible benches are indicated.
 2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
- C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
 1. Tubular Steel: 1-1/2-inch- (38-mm-) diameter steel tubing threaded on both ends, with standard pipe flange at top and bell-shaped cast-iron base; with baked-enamel or powder-coat finish; anchored with exposed fasteners.
 - a. Color: Match metal lockers.
- D. Materials:
 1. Stainless Steel: ASTM A 666, Type 304.
 2. Steel Tube: ASTM A 500/A 500 M, cold rolled.

2.6 FABRICATION

- A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
- C. Equipment: Provide each locker with an identification plate and the following equipment:
 1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
 2. Coat Rods: For each compartment of each locker.
- D. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.
- E. Accessible Lockers: Fabricate as follows:

1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.
- F. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
- G. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- H. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
1. Provide one-piece panels for double-row (back-to-back) locker ends.

2.7 ACCESSORIES

- A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- B. Anchors: Material, type, and size required for secure anchorage to each substrate.
1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls, and elsewhere as indicated, for corrosion resistance.
 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 2. Anchor single rows of metal lockers to walls near top and bottom of lockers of lockers and to floor.
 3. Anchor back-to-back metal lockers to floor.
- B. Welded Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.
- C. Equipment:
1. Attach hooks with at least two fasteners.
 2. Attach door locks on doors using security-type fasteners.

3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
- D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 1. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
 2. Attach sloping-top units to metal lockers, with closures at exposed ends.
 3. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.
- E. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

3.3 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

3.4 PROTECTION

- A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION

SECTION 113013 - RESIDENTIAL APPLIANCES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Kitchen appliances.
- B. Laundry appliances.

1.02 RELATED REQUIREMENTS

- A. Division 22 Section - Plumbing Piping: Plumbing connections for appliances.
- B. Division 26 Section - Wiring Connections: Electrical connections for appliances.

1.03 REFERENCE STANDARDS

- A. UL (DIR) - Online Certifications Directory Current Edition.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Electric Appliances: Listed and labeled by UL (DIR) and complying with NEMA Standards (National Electrical Manufacturers Association).

1.05 WARRANTY

- A. See Division 01 Section - Closeout Submittals, for additional warranty requirements.
- B. Provide five (5) year manufacturer warranty on refrigeration system of refrigerators.
- C. Provide ten (10) year manufacturer warranty on magnetron tube of microwave ovens.

PART 2 - PRODUCTS

2.01 KITCHEN APPLIANCES

- A. Provide Equipment Eligible for Energy Star Rating: Energy Star Rated.
- B. Refrigerator : Free-standing, side-by-side, and frost-free.
 - 1. Capacity: Total minimum storage of 18 cubic ft (0.51 cu m); minimum 15 percent freezer capacity.
 - 2. Energy Usage: Minimum 20 percent more energy efficient than energy efficiency standards set by U.S. Department of Energy (DOE).
 - 3. Features: Include .
 - 4. Exterior Finish: Porcelain enameled steel, color as indicated.

5. Manufacturers:

C. Microwave: Countertop.

1. Capacity: 0.7 cubic ft (0.019 cu m).
2. Power: 700 watts.
3. Features: Include turntable, cooktop light, night light and 2-speed exhaust fan.
4. Exterior Finish: tbd
5. Manufacturers:
 - a. Frigidaire Home Products: www.frigidaire.com
 - b. GE Appliances: www.geappliances.com
 - c. Whirlpool Corp: www.whirlpool.com

2.02 LAUNDRY APPLIANCES

A. Provide Equipment Eligible for Energy Star Rating: Energy Star Rated.

A. Clothes Washer: Front-loading.

1. Size: Full-size.
2. Controls: Solid state electronic.
3. Cycles: Include normal, permanent press, delicate, soak, and automatic soak.
4. Motor Speed: Single-speed.
5. Features: Include optional second rinse, bleach dispenser, fabric softener dispenser, self-cleaning lint filter, sound insulation, and end of cycle signal.
6. Finish: Painted steel , color as indicated.
7. Manufacturers:
 - a. Frigidaire Home Products: www.frigidaire.com
 - b. GE Appliances: www.geappliances.com
 - c. Whirlpool Corp: www.whirlpool.com

B. Clothes Dryer: Electric, stationary.

1. Size: Full-size.
2. Controls: Solid state electronic, with electronic moisture-sensing dry control.
3. Temperature Selections: One.
4. Cycles: Include normal, permanent press, knit/delicate, and air only.
5. Features: Include interior light, reversible door, stationary rack, sound insulation, and end of cycle signal, Long Vent
6. Finish: Painted steel , color as indicated.
7. Manufacturers:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide 7.4 cu.ft Front Load Long Vent Electric Dryer with Intuitive Controls, or a comparable product.
 - b. Whirlpool Corp: www.whirlpool.com
 - c. Frigidaire Home Products: www.frigidaire.com
 - d. GE Appliances: www.geappliances.com

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify utility rough-ins are provided and correctly located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Anchor built-in equipment in place.

3.03 ADJUSTING

- A. Adjust equipment to provide efficient operation.

3.04 CLEANING

- A. Remove packing materials from equipment and properly discard.
- B. Wash and clean equipment.

END OF SECTION

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SECTION 12 24 13 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated roller shades with single rollers.
- B. Related Requirements:
 - 1. Division 06 Section "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
 - 2. Division 07 Section "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- D. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop

Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Basis of Design Product: SWF Contract, Solar Shading Systems, Manual Solar Shade.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Stainless steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide stainless steel upper and lower ball stops.
 - 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 6 lbs or for shades as recommended by manufacturer, whichever criteria are more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: Left side of inside face of shade.
 - 2. Direction of Shadeband Roll: Regular, from back of roller.
 - 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:
 - 1. Shadeband Material: Light-filtering fabric. 5% Open.
 - a. Basis of Design: SWF "Sheerweave" 2000, White/Platinum, P0520
 - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Color and Finish: As selected by Architect from manufacturer's full range.
- F. Installation Accessories:
 - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 3 inches.
 - 2. Endcap Covers: To cover exposed endcaps.

3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MANUALLY OPERATED LIGHT-BLOCKING SHADES WITH SINGLE ROLLERS

- A. Basis of Design Product: SWF Contract, Solar Shading Systems, Manual Solar Shade.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 1. Bead Chains: Stainless steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide stainless steel upper and lower ball stops.
 2. Spring Lift-Assist Mechanisms: Manufacturer's standard for balancing roller-shade weight and lifting heavy roller shades.
 - a. Provide for shadebands that weigh more than 6 lbs or for shades as recommended by manufacturer, whichever criteria are more stringent.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 1. Roller Drive-End Location: Left side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:
 1. Shadeband Material: Light-blocking fabric. 0% Open
 - a. Basis of Design: SWF "Sheerweave" 7100, White/Platinum, P0571
 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Color and Finish: As selected by Architect from manufacturer's full range.
- F. Installation Accessories:
 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and shadeband when shade is fully open, but not less than 3 inches.
 2. Endcap Covers: To cover exposed endcaps.
 3. Side Channels: With light seals and designed to eliminate light gaps at sides of shades as shades are drawn down. Provide side channels with shadeband guides or other means of aligning shadebands with channels at tops.
 4. Bottom (Sill) Channel or Angle: With light seals and designed to eliminate light gaps at bottoms of shades when shades are closed.
 5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 - 1. Source: SWF "Sheerweave".
 - 2. Type: PVC-coated fiberglass.
 - 3. Weave: Mesh.
 - 4. Roll Width: match window width.
 - 5. Openness Factor: 5 percent.
 - 6. Color: As indicated by manufacturer's designation.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 - 1. Source: SWF "Sheerweave".
 - 2. Type: PVC-coated fiberglass with bonded PVC film.
 - 3. Roll Width: match window width.
 - 4. Color: As indicated by manufacture's designation.

2.5 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 - 1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
 - 1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
 - 1. Opaque Shadebands: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

END OF SECTION

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SECTION 13 34 19 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Municipality of Anchorage Standard Specifications (MASS), General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Structural-steel framing.
 - 2. Miscellaneous support framing and accessories.
- B. Related Sections:
 - 1. Section 074300-INSULATED METAL ROOF AND WALL PANELS, for insulated core metal roof and exterior wall panels.
 - 2. Section 076200-SHEET METAL FLASHING AND TRIM, for sheet metal flashing.
 - 3. Section 083613-SECTIONAL DOORS, for overhead doors.
 - 4. Section 08 11 13 - HOLLOW METAL DOORS AND FRAMES, for insulated hollow metal exterior doors.

1.3 DEFINITIONS

- A. Terminology Standard: See MBMA's "Metal Building Systems Manual" for definitions of terms for metal building system construction not otherwise defined in this Section or in referenced standards.

1.4 SUBMITTALS

- A. Product Data: For each type of metal building system component. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - 1. Structural-steel-framing system.
 - 2. Miscellaneous support framing and accessories.

- B. Shop Drawings: For the following metal building system components. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Anchor-Bolt Plans: Submit anchor-bolt plans and templates before foundation work begins. Include location, diameter, and projection of anchor bolts required to attach metal building to foundation. Indicate column reactions at each location.
 - 2. Structural-Framing Drawings: Show complete fabrication of primary and secondary framing; include provisions for openings. Indicate welds and bolted connections, distinguishing between shop and field applications. Include transverse cross-sections.
- C. Design Submittal: Submit compliance with performance requirements and design criteria, including analysis data and structural calculations signed and sealed by the qualified professional engineer, licensed in the State of Alaska and responsible for their preparation.
- D. Qualification Data: For qualified erector, manufacturer, and professional engineer.
- E. Welding certificates.
- F. Metal Building System Certificates: For each type of metal building system, from manufacturer.
 - 1. Letter of Design Certification: Signed and sealed by a qualified professional engineer, licensed in the State of Alaska. Include the following:
 - a. Name and location of Project.
 - b. Order number.
 - c. Name of manufacturer.
 - d. Name of Contractor.
 - e. Building dimensions including width, length, height, and roof slope.
 - f. Indicate compliance with AISC standards for hot-rolled steel and AISI standards for cold-rolled steel, including edition dates of each standard.
 - g. Governing building code and year of edition.
 - h. Design Loads: Include dead load, roof live load, collateral loads, roof snow load, deflection, wind loads/speeds and exposure, seismic design category or effective peak velocity-related acceleration/peak acceleration, and auxiliary loads (cranes).
 - i. Load Combinations: Indicate that loads were applied acting simultaneously with concentrated loads, according to governing building code.
 - j. Building-Use Category: Indicate category of building use and its effect on load importance factors.
 - k. AISC Certification for Category MB: Include statement that metal building system and components were designed and produced in an AISC-Certified Facility by an AISC-Certified Manufacturer.
- G. Finish: Submit all applicable procedures, specifications, suppliers, and contractors used for applying the finish and galvanizing for secondary structural framing and accessory components.
- H. Erector Certificates: For each product, from manufacturer.

- I. Material Test Reports: For each of the following products:
 - 1. Structural steel including chemical and physical properties.
 - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
 - 3. Tension-control, high-strength, bolt-nut-washer assemblies.
 - 4. Primers, paint, and other coatings.
- J. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for insulation and vapor-retarder facings. Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.
- K. Source quality-control reports.
- L. Warranties: Sample of special warranties.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer and member of MBMA.
 - 1. AISC Certification for Category MB: An AISC-Certified Manufacturer that designs and produces metal building systems and components in an AISC-Certified Facility.
 - 2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer, licensed in the state of Alaska.
- B. Erector Qualifications: An experienced erector who specializes in erecting and installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.
- C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- D. Source Limitations: Obtain metal building system components, including primary and secondary framing, from single source from single manufacturer.
- E. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3, "Structural Welding Code - Sheet Steel."
- F. Structural Steel: Comply with AISC 360, "Specification for Structural Steel Buildings," for design requirements and allowable stresses.
- G. Cold-Formed Steel: Comply with AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members" for design requirements and allowable stresses.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components and other manufactured items so as not to be damaged or deformed. Package metal panels for protection during transportation and handling.
- B. Unload, store, and erect metal panels in a manner to prevent bending, warping, twisting, and surface damage.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when weather conditions permit metal building systems to be installed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements:
 - 1. Established Dimensions for Foundations: Comply with established dimensions on approved anchor-bolt plans, establishing foundation dimensions and proceeding with fabricating structural framing without field measurements. Coordinate anchor-bolt installation to ensure that actual anchorage dimensions correspond to established dimensions.
 - 2. Established Dimensions for Metal Panels: Coordinate framing and opening dimensions with approved metal wall and roof panel shop drawings. Coordinate construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete foundations and casting of anchor-bolt into foundation walls and footings. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of equipment supports, and roof penetrations.
- C. Coordinate installation of guard rail structure, future solar panels, and other equipment.

1.9 WARRANTY

- A. Provide manufacturer's standard warranty for metal building components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Butler Manufacturing Company; a BlueScope Steel company.
 2. Garco Building Systems; Division of NCI Building Systems, L.P.
 3. Star Building Systems; an NCI company.
 4. VP Buildings; a United Dominion company.

2.2 METAL BUILDING SYSTEMS

- A. Description: Provide a complete, integrated set of metal building system manufacturer's standard mutually dependent components and assemblies that form a metal building framing system capable of withstanding structural and other loads, and thermally induced movement without failure or infiltration of water into building interior.
1. Provide metal building system of size and with bay spacings, roof slopes, and spans indicated.
- B. Base Bid Primary-Frame Type:
1. Rigid Modular: Solid-member, structural-framing system with interior columns.
 2. End-Wall Framing: Manufacturer's standard, consisting of primary frame, capable of supporting full bay design load, and overhead and man door framing.
- C. Secondary-Frame Type: Manufacturer's standard purlins, joists and exterior-framed (bypass) girts.
- D. Eave Height: As indicated on Drawings, with minimum 18'-0" at the primary frame "haunch".
- E. Bay Spacing: As indicated on Drawings.
- F. Roof Slope: As indicated on Drawings.
- G. Roof System: Insulated metal panels, specified in Division 7.
- H. Exterior Wall System: Insulated metal panels, specified in Division 7.

2.3 METAL BUILDING SYSTEM PERFORMANCE

- A. Delegated Design: Design metal building system, including comprehensive engineering analysis by a qualified professional engineer, licensed in the State of Alaska, using performance requirements and design criteria indicated.
- B. Structural Performance: Metal building systems shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to procedures in MBMA's "Metal Building Systems Manual."
 - 1. Design Loads: As indicated on Structural Drawings.
 - 2. Deflection Limits: Design metal building system assemblies to withstand design loads with deflections no greater than the following:
 - a. Purlins and Rafters: Vertical deflection of 1/180 of the span.
 - b. Girts: Horizontal deflection of 1/180 of the span.
 - c. Design secondary-framing system to accommodate deflection of primary framing and construction tolerances, and to maintain clearances at openings.
 - 3. Drift Limits: Engineer building structure to withstand wind loads with drift limits no greater than the following:
 - a. Lateral Drift: Maximum of 1/200 of the building height.
- C. Seismic Performance: Metal building systems shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
- D. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 100 deg F, ambient; 120 deg F, material surfaces.

2.4 STRUCTURAL-STEEL FRAMING

- A. Primary Framing: Manufacturer's standard primary-framing system, designed to withstand required loads and specified requirements.
- B. General: Provide frames with attachment plates, bearing plates, and splice members. Factory drill for field-bolted assembly. Provide frame span and spacing indicated.
 - 1. Slight variations in span and spacing may be acceptable if necessary to comply with manufacturer's standard, as approved by Architect.

2. Rigid Clear-Span Frames: I-shaped frame sections fabricated from shop-welded, built-up steel plates or structural-steel shapes. Interior columns are permitted only where indicated.
 3. Frame Configuration: Mono-slope shed.
 4. Exterior Column Type: Tapered.
 5. Rafter Type: Tapered.
- C. End-Wall Framing: Rigid clear span frame with steel framing for overhead and man doors.
- D. Secondary Framing: Manufacturer's standard secondary framing, including purlins, girts, eave struts, flange bracing, base members, gable angles, clips, headers, jambs, and other miscellaneous structural members. Unless otherwise indicated, fabricate framing from either cold-formed, structural-steel sheet or roll-formed, metallic-coated steel sheet, pre-coated or post fabrication applied hot-dip galvanizing G-90, to comply with the following:
1. Purlins: Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; minimum 2-1/2-inch- wide flanges.
 - a. Depth: As needed to comply with system performance requirements.
 - b. Spacing: As needed to comply system performance requirements, and span limitations of metal roof panels.
 2. Girts: Z-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes. Form ends of Z-sections with stiffening lips angled 40 to 50 degrees from flange, with minimum 2-1/2-inch- wide flanges.
 - a. Depth: 8-inches, or as needed to comply with system performance requirements. Depth greater than 8-inches shall require matching increase to concrete stem wall thickness.
 - b. Spacing: As needed to comply system performance requirements, and span limitations of metal wall panels.
 3. Eave Struts: Unequal-flange, C-shaped sections; fabricated from built-up steel plates, steel sheet, or structural-steel shapes; to provide adequate backup for metal panels.
 4. Flange Bracing: Not permitted at columns. Manufacturer's standard members may be used for roof framing.
 5. Sag Bracing: Minimum 1-by-1-by-1/8-inch structural-steel angles.
 6. Base Channels: Minimum 2-by-8-inch steel sheet.
 7. Purlin and Girt Clips: Manufacturer's standard clips fabricated from steel sheet.
 8. Secondary End-Wall Framing: Manufacturer's standard sections.
 9. Framing for Openings: Channel shapes; fabricated from cold-formed, structural-steel sheet or structural-steel shapes. Frame head and jamb of door openings and head, jamb, and sill of other openings.
 10. Miscellaneous Structural Members: Manufacturer's standard sections fabricated from cold-formed, structural-steel sheet; built-up steel plates; designed to withstand required loads.

E. Bracing: Provide adjustable wind bracing as follows:

1. Rods: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50; or ASTM A 529/A 529M, Grade 50; minimum 1/2-inch- diameter steel; threaded full length or threaded a minimum of 6 inches at each end. Hot-dip galvanized finish.
2. Angles: Fabricated from structural-steel shapes to match primary framing, of size required to withstand design loads. Hot-dip galvanized finish.

F. Bolts: Provide bolts finished with mechanically applied zinc or Dacromet coating for structural-framing components that are primed or finish painted. Provide hot-dip galvanized bolts for structural-framing components that are galvanized.

G. Materials:

1. W-Shapes: ASTM A 992/A 992M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
2. Channels, Angles, M-Shapes, and S-Shapes: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
3. Plate and Bar: ASTM A 36/A 36M; ASTM A 572/A 572M, Grade 50 or 55; or ASTM A 529/A 529M, Grade 50 or 55.
4. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade B.
5. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B or C, structural tubing.
6. Structural-Steel Sheet: Hot-rolled, ASTM A 1011/A 1011M, Structural Steel (SS), Grades 30 through 55, or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70; or cold-rolled, ASTM A 1008/A 1008M, Structural Steel (SS), Grades 25 through 80, or High-Strength Low-Alloy Steel (HSLAS), Grades 45 through 70.
7. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet, metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - a. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grades 33 through 80, or High-Strength Low-Alloy Steel (HSLAS), Grades 50 through 80; with G90 coating designation.
8. Non-High-Strength Bolts, Nuts, and Washers: ASTM A 307, Grade A, carbon-steel, hex-head bolts; ASTM A 563 carbon-steel hex nuts; and ASTM F 844 steel washers.
 - a. Finish: Dacromet coating, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.
9. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563 heavy-hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
 - a. Finish: Dacromet coating, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

10. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F 1852, Type 1, heavy-hex-head steel structural bolts with spline ends.
 - a. Finish: Dacromet coating, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.
11. Headed Anchor Rods: ASTM F 1554.
 - a. Configuration: Straight.
 - b. Nuts: ASTM A 563 hex carbon steel.
 - c. Plate Washers: ASTM A 36/A 36M carbon steel.
 - d. Washers: ASTM F 436 hardened carbon steel.
 - e. Finish: Dacromet coating, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.
12. Threaded Rods: ASTM A 193/A 193M or ASTM A 572/A 572M, Grade 50 or ASTM A 36/A 36M or ASTM A 307, Grade A.
 - a. Nuts: ASTM A 563 hex carbon steel.
 - b. Washers: ASTM A 36/A 36M carbon steel.
 - c. Finish: Dacromet coating, Hot-dip zinc coating, ASTM A 153/A 153M, Class C or Mechanically deposited zinc coating, ASTM B 695, Class 50.

H. Finish:

1. Primary & Secondary framing members:
 - a. Factory primed. Apply specified primer immediately after cleaning and pretreating.
 - b. Clean and prepare in accordance with SSPC-SP2.
 - c. Coat with manufacturer's standard primer. Apply primer to primary and secondary framing to a minimum dry film thickness of 1 mil.

2.5 ACCESSORIES

- A. General: Provide accessories as standard with metal building system manufacturer and as specified. Fabricate and finish accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes. Comply with indicated profiles and with dimensional and structural requirements.
 1. Form exposed sheet metal accessories that are without excessive oil-canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.

- B. Roof Panel Accessories: Provide secondary framing components required to complete metal roof panel assembly.
- C. Wall Panel Accessories: Provide secondary framing components required to complete metal wall panel assembly.
- D. Materials:
 - 1. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide fasteners with heads matching color of materials being fastened by means of plastic caps or factory-applied coating.
 - 2. Corrosion-Resistance: Hot-dip galvanized or stainless steel.
 - 3. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.6 SOURCE QUALITY CONTROL

- A. Testing: Inspect shop connections for metal buildings according to the following:
 - 1. Bolted Connections: Shop-bolted connections shall be inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 2. Welded Connections: In addition to visual inspection, shop-welded connections shall be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at inspector's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.
- B. Product will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

2.7 FABRICATION

- A. General: Design components and field connections required for erection to permit easy assembly.
 - 1. Mark each piece and part of the assembly to correspond with previously prepared erection drawings, diagrams, and instruction manuals.

2. Fabricate structural framing to produce clean, smooth cuts and bends. Punch holes of proper size, shape, and location. Members shall be free of cracks, tears, and ruptures.
- B. Tolerances: Comply with MBMA's "Metal Building Systems Manual" for fabrication and erection tolerances.
- C. Primary Framing: Shop fabricate framing components to indicated size and section, with baseplates, bearing plates, stiffeners, and other items required for erection welded into place. Cut, form, punch, drill, and weld framing for bolted field assembly.
 1. Make shop connections by welding or by using high-strength bolts.
 2. Join flanges to webs of built-up members by a continuous, submerged arc-welding process.
 3. Design primary framing, girts and purlins to eliminate the need for flange bracing.
 4. Weld clips to frames for attaching secondary framing.
- D. Secondary Framing: Shop fabricate framing components to indicated size and section by roll-forming or break-forming, with baseplates, bearing plates, stiffeners, and other plates required for erection welded into place. Cut, form, punch, drill, and weld secondary framing for bolted field connections to primary framing.
 1. Make shop connections by welding or by using non-high-strength bolts.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with erector present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Before erection proceeds, survey elevations and locations of concrete-bearing surfaces and locations of anchor rods, bearing plates, and other embedments to receive structural framing, with erector present, for compliance with requirements and metal building system manufacturer's tolerances.
 1. Engage land surveyor to perform surveying.
- C. Proceed with erection only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition.

- B. Provide temporary shores, guys, braces, and other supports during erection to keep structural framing secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural framing, connections, and bracing are in place unless otherwise indicated.

3.3 ERECTION OF STRUCTURAL FRAMING

- A. Erect metal building system according to manufacturer's written erection instructions and erection drawings.
- B. Do not field cut, drill, or alter structural members without written approval from metal building system manufacturer's professional engineer.
- C. Set structural framing accurately in locations and to elevations indicated, according to AISC specifications referenced in this Section. Maintain structural stability of frame during erection.
- D. Base and Bearing Plates: Clean concrete-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- E. Align and adjust structural framing before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with framing. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure will be completed and in service.
- F. Primary Framing and End Walls: Erect framing level, plumb, rigid, secure, and true to line. Level baseplates to a true even plane with full bearing to supporting structures, set with double-nutted anchor bolts. Use grout to obtain uniform bearing and to maintain a level base-line elevation. Moist-cure grout for not less than seven days after placement.
 - 1. Make field connections using high-strength bolts installed according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for bolt type and joint type specified.
 - a. Joint Type: Snug tightened or pretensioned.

- G. Secondary Framing: Erect framing level, plumb, rigid, secure, and true to line. Field bolt secondary framing to clips attached to primary framing.
 - 1. Provide rake or gable purlins with tight-fitting closure channels and fasciae.
 - 2. Locate and space wall girts to suit openings such as doors and windows.
 - 3. Provide supplemental framing at entire perimeter of openings, including doors, windows, louvers, ventilators, and other penetrations of roof and walls.
- H. Bracing: Install bracing in roof and sidewalls where indicated on erection drawings.
 - 1. Tighten rod and cable bracing to avoid sag.
 - 2. Locate interior end-bay bracing only where indicated.
- I. Framing for Openings: Provide shapes of proper design and size to reinforce openings and to carry loads and vibrations imposed, including equipment furnished under mechanical and electrical work. Securely attach to structural framing.
- J. Erection Tolerances: Maintain erection tolerances of structural framing within AISC 303.

3.4 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections required by building codes or local authorities having jurisdiction.
- B. Tests and Inspections:
 - 1. High-Strength, Field-Bolted Connections: Connections shall be inspected during installation according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
 - 2. Welded Connections: In addition to visual inspection, field-welded connections shall be tested and inspected according to AWS D1.1/D1.1M and the following inspection procedures, at inspector's option:
 - a. Liquid Penetrant Inspection: ASTM E 165.
 - b. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration will not be accepted.
 - c. Ultrasonic Inspection: ASTM E 164.
 - d. Radiographic Inspection: ASTM E 94.

- C. Product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Doors: After completing installation, test doors, windows and other openings to ensure proper operation. Correct secondary framing as required.

3.7 CLEANING AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After erection, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted structural framing, bearing plates, and accessories.
 - 1. Use same finish method as required for the material supplied.

END OF SECTION 13 34 19

SECTION 22 00 00
GENERAL MECHANICAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

- A. Provisions of this section shall apply to sections in Divisions 21, 22, 23, and 26.

1.02 SCOPE

- A. Furnish labor, materials, equipment, supervision of labor, and performance of operations required to completely install operating mechanical and plumbing systems as defined herein and on Drawings.
- B. Major items of work include, but are not limited to, the installation of the following systems:
1. Plumbing.
 2. Fuel piping.
 3. Heat generation.
 4. Ventilation and air distribution.
 5. Liquid heat transfer.
 6. Controls and instrumentation systems.
 7. Electrical Devices
- C. Other divisions of these specifications apply to work generally defined by Division 21, 22, 23, and 26 specifications and/or shown on Drawings. For additional details, refer to drawings detailing work under other divisions. Work shown on the "M" series drawings and Division 21, 22, 23, and 26 specifications is to be provided unless otherwise stated.
- D. The drawings and specifications are complementary to each other. What is shown on one is as binding as if called for in both. The mechanical drawings are generally diagrammatic and are intended to show mechanical details in a schematic fashion. Do not scale mechanical drawings. Exact locations are not shown unless so indicated or specifically dimensioned. Typical connection diagrams are schematic and do not show the actual physical arrangement of equipment. The plans do not necessarily show complete details of the features which affect the mechanical installations; however, it is the intent of the contract documents to provide a complete and satisfactorily working installation.
- E. Submit in writing to the Department for review details of proposed departures from these Contract Documents and reasons therefore, within 30 days after the award of the contract. Make no departure without prior written approval of the Department.
- F. Coordination of the Work: Coordinate work under this Division with work of other trades to avoid conflicts, errors, and delays.
- G. Verify the approximate location of equipment and mechanical system components shown on the Drawings and report conflicts with openings, structural members, and components of systems and equipment having fixed locations.

- H. If, during the course of accomplishing the work defined herein and on the Contract Drawings, the Contractor discovers major damage, defect or deterioration to existing equipment or systems indicated as existing to remain, and where such damage, defect or deterioration will or might effect the safe and proper operation of such equipment and systems, the Contractor shall immediately notify the Department in writing.

1.03 REFERENCES

- A. Codes and Standards: Work and materials shall comply with the latest issues of the following:
1. International Building Code (IBC).
 2. Air Moving and Conditioning Association (AMCA).
 3. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE).
 4. American Society of Mechanical Engineers (ASME).
 5. National Fire Protection Association (NFPA).
 6. Uniform Plumbing Code (UPC).
 7. American Society for Testing Materials (ASTM).
 8. American Water Works Association (AWWA).
 9. American Welding Society (AWS).
 10. Hydraulic Institute (HI).
 11. National Bureau of Standards (NBS).
 12. National Electrical Code (NEC).
 13. National Electrical Manufacturers Association (NEMA).
 14. Underwriters' Laboratories, Inc. (UL).
 15. American National Standards Institute (ANSI).
 16. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
 17. International Mechanical Code (IMC).
 18. Air-Conditioning and Refrigeration Institute (ARI).
 19. International Fire Code (IFC).
 20. All base materials shall comply with standards of ASTM and ANSI.
 21. Occupational Safety and Health Administration (OSHA).
 22. Environmental Protection Agency (EPA).
 23. National Environmental Balancing Bureau (NEBB).

1.04 QUALITY ASSURANCE

- A. All work and materials shall be in accordance with applicable codes, standards and ordinances, rules, and regulations of the Fire Marshal and of the utility companies. Nothing in the Drawings and Specifications shall be construed as requiring or permitting work in violation of such codes.
- B. Rulings and interpretations of the Agencies Having Jurisdiction shall be considered as part of the codes and regulations if commonly known to the trade prior to bidding.
- C. Whenever the Drawings and Specifications require higher standards than the codes and regulations, the Drawings and Specifications shall govern.
- D. Only craftsmen skilled in their trade shall be employed.
- E. Fire-Rated Systems: Maintain the integrity of fireproofing materials, systems, rated partitions, and floors at mechanical penetrations.

1.05 SUBMITTALS

- A. Submit shop drawings material data sheets, manufacturer's literature, and other items as specified in Division 01 and the individual sections of Division 22 and 23.
 - 1. Submit shop drawings of product that are not the standard catalog product of an established manufacturer and is fabricated for or by the Contractor.
 - 2. Submit shop drawings and other items as herein specified in the individual Sections.
 - 3. Include with shop drawings of fabricated items the basis of design and design calculations.
 - 4. Samples: Submit samples of materials as requested by the Department. Shop Drawings and Manufacturer's Literature:

1.06 CLOSEOUT SUBMITTALS

- A. Submit certifications and testing reports as specified in Division 01 and the individual sections of Divisions 22 and 23.
- B. Operating and Maintenance Data:
 - 1. Provide six sets of each type of instructions, bound together in D-ring metal-ringed hardcover binders with removable pages, with a typewritten index indicating location of items in the work. Information not pertinent to this work shall be deleted or neatly and completely lined out. Binders shall be of capacity to allow a minimum of 20 percent expansion.
 - 2. Provide latching, metal, wall mounted boxes of adequate size for storage of O&M manuals in mechanical and fan rooms. Boxes should be labeled "O&M Data" and include a hook installed at the bottom of the box for hanging of laminated material.
 - 3. The following components shall be printed so as not to fade, laminated with a brass grommet punch in the corner, affixed with a lanyard, and mounted in a convenient location in the respective mechanical room where the equipment and/or systems are located:
 - a. Pipe and duct identification schedules.
 - b. Valve directory.
 - c. Equipment Nameplate directory.
 - d. System schematic drawings.
 - e. Plumbing and electric riser diagrams.
 - f. DDC Control drawings required under Section 23 09 23 – Direct Digital Control System, paragraph 1.7.C Operations and Maintenance Data.
 - g. Master maintenance schedule.
- C. Operating and maintenance data must be provided for Department approval at least 30 days prior to Substantial Completion. If approved operation and maintenance instructions are not on hand at the time of Substantial Completion and/or occupancy, the Contractor, at their own expense, shall make repairs, replacement and installation of components that may be destroyed or damaged due to the absence of specified instructions, and shall hold the Department harmless.
- D. Submit mechanical HVAC system start-up, testing, commissioning, and demonstration plans.
- E. Submit controls system start-up and demonstration plans.
- F. Submit a mechanical system operating instruction training schedule complete with class outline lesson plan that includes training topics and durations.
- G. Provide approved O&M in digital "PDF" format for use in addition to hard copies specified above.

1.07 PROJECT CONDITIONS

- A. Site Visit: It is advised that the Contractor visit the site and verify the exact conditions relating to their work and obtain such information as may be necessary to provide an intelligent and conclusive bid. No allowance will be made on behalf of the Contractor for extra expense due to failure on their part to make a visit.
- B. Protection: Protect surrounding areas and surfaces to preclude damage due to the installation of material or equipment. Unfinished work shall be temporarily protected from unsafe conditions and damage.
- C. Sequencing and Scheduling: Coordinate the scheduling of equipment and material installations with other affected trades to avoid conflicts. If, during the course of construction, conditions are discovered which adversely affect the mechanical work, immediately notify the Department before proceeding. Advise other trades of openings required in their work for the subsequent installation of mechanical work or equipment.

1.08 INSPECTION

- A. Work and materials shall be subject to inspection by the Department's Representative and by the agencies having jurisdiction.
- B. Any work or materials found to be damaged or defective or not conforming to the requirements of the Drawings or Specifications, or to the approved finish aesthetic appearance of the job, shall be removed and replaced as directed by the Department's Representative.

1.09 ELECTRICAL REQUIREMENTS

- A. All electrical work, equipment, assemblies, wiring, devices, and components shall comply with the requirements of local and national electrical codes and with Division 26.
- B. All electrical equipment, assemblies, devices, and components which are tested by Underwriters Laboratories, Inc. shall be UL listed and shall bear a UL label.
- C. Unless otherwise indicated on the electrical drawings, mechanical equipment motors and controls shall be furnished, set in place, and wired in accordance with the following schedule:

	<u>FURNISHED UNDER DIVISION</u>	<u>SET IN PLACE BY DIVISION</u>	<u>LINE VOLTAGE POWER UNDER DIVISION</u>	<u>MECH CONTROL</u>
Equipment Motors	23	23	26	23
Magnetic Motor Starters:				
a. Automatically controlled	26	26	26	23
b. Manually controlled	26	26	26	23
c. In packaged equipment	23	23	26	23
d. Disconnect switches, manual motor starters, thermal overload switches	26	26	26	--
e. Control relays, transformers, time clocks, thermostats, motor valves, float controls, damper motors, EP and PE switches and other miscellaneous	23	23	26	23
Division 22 and 23 Controls				

- D. Factory wired assemblies and panels shall be prewired to numbered terminal strips for connection to field wiring.

1.10 USE OF HEATING SYSTEMS DURING CONSTRUCTION

- A. The Contractor is free to use or operate the heating system, provided the operation is approved in writing by the Department. Operation of the air delivery system during construction shall only be done with specified filters properly installed.
- B. When construction is complete, the Contractor shall install new filters at no additional expense to the Department. The Contractor shall pay for energy used until acceptance of the building.

1.11 GUARANTEE

- A. Neither the final certificate of payment, nor provisions in the Contract Documents, nor partial or entire occupancy of the premises by the Department shall constitute an acceptance of work not done in accordance with the Contract Documents or relieve the Contractor of liability in respect to express warranties or responsibilities for faulty materials or workmanship.
- B. Contractor shall remedy defects in the work and pay for damage to other work resulting therefrom which shall appear within a period one year from the date of final acceptance of work unless a longer period is specified. The Department will give notice of observed defects with reasonable promptness.

1.12 OPERATING AND MAINTENANCE DATA

- A. The Contractor shall prepare operating and maintenance instructions containing information to operate, prolong service life or replace parts of the work. Operating and maintenance data shall specifically include:
 - 1. List of contractors' and subcontractors' names, addresses, and telephone numbers.
 - 2. List of equipment and material manufacturers' local representatives and suppliers and their addresses and telephone numbers.
 - 3. Pipe and duct identification schedules.
 - 4. Nameplate directory with a list of equipment indicating designation, location of equipment, manufacturers' name, model number, serial number, electrical characteristics, primary control switch location and normal position of switch.
 - 5. Valve directory indicating valve number, size, location, function, service, type, and normal position.
 - 6. Boiler factory start-up testing report.
 - 7. Air and hydronic test and balance report.
- B. Equipment Literature: For equipment, fixtures, devices, valves, and specialties, provide the following:
 - 1. Manufacturer's data sheets and cut sheets.
 - 2. Model and serial numbers.
 - 3. Capacity curves, charts, and calculations.
 - 4. Electrical characteristics.
 - 5. Replacement parts list.
 - 6. As-built equipment piping diagrams.
 - 7. As-built equipment wiring diagrams.
 - 8. Manufacturer's instructions for operation and maintenance.
 - 9. Completely mark out on literature sheets non-applicable items.
 - 10. Where piping and wiring diagrams are not available from the manufacturer, they shall be produced by the Contractor.
 - 11. Literature shall be grouped together by system, i.e., plumbing, heat generation, etc. For each system section, the Contractor shall produce and include a basic system written narrative description. Each narrative shall be comprised of the following:
 - a. Brief system description, including sequence of operation.
 - b. Basic system function discussion, including interaction with other systems or components.
 - c. Primary system preventive maintenance procedures.

- d. How to isolate major components.
 - e. How to drain, fill, and vent liquid system.
 - f. How to drain, clean, and refill tanks, pumps, and tube bundles.
 - g. How to clean coils and change air filters for air systems.
 - h. Emergency shut-down procedures.
- C. System Schematic Drawings:
 - 1. System Schematic Drawings: Contractor shall produce and include in the maintenance manuals, simplified schematic drawings of the mechanical systems, specifically including, but not restricted to the following systems:
 - a. Hydronic heating and cooling systems.
 - b. Ventilation and exhaust systems.
 - c. Domestic water systems.
 - d. Oily waste collection system
 - e. Shop compressed air systems.
 - f. HVAC DCC systems.
 - g. Fuel oil systems.
 - h. Fire suppression systems.
 - 2. Schematic drawings shall show in simplified form, major equipment and equipment components, control dampers, control valves, and valves or devices used during normal system operation, maintenance work or emergency functions.
 - a. Show the primary flow paths for air and hydronic systems.
 - b. Reference shown equipment, devices, ducts, zones, controls devices, piping and valves by the designations and identification tags listed in the valve directory nameplate directory, duct schedule and pipe coding schedules.
- D. Master Maintenance Schedule: List each item of equipment requiring inspection and maintenance, showing component maintenance required and the intervals when such inspection and maintenance shall be performed (daily, weekly, monthly, semi-annually, etc.). For each item, reference the page within the maintenance manual where detailed manufacturer's maintenance instructions can be found.
- E. Contractor shall provide wall-mounted latching metal boxes of sufficient size to hold O&M data in each mechanical room to include a set of full size as-builts.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be those of major and reputable manufacturers with ability to render competent and thorough service through local organizations and expeditiously to provide spare parts.
- B. In addition to material and equipment specified, also provide incidental materials required to effect complete installation. Such incidental materials include solders, tapes, caulking, mastics, gaskets, etc.
- C. Mixes, Compounds, Dopes, Tapes, and Fluxes: mixes, compounds, dopes, tapes, and fluxes shall be fresh, highest quality, free of contaminants, of the type and grade suitable for the intended use in each case. Where more than one type of mix, etc. is specified for the same service, select one type; however, state which type is proposed for use in the submittal material and in no case more than one type is to be used in a specific mechanical system. Where two or more units of the same mix, etc., are required, provide products of a single manufacturer. Provide mixes, etc., bearing approval stamps wherever standards have been established.
- D. Comply with governing regulations and industry standards for selections, and with manufacturers' recommendations where applicable.

- E. Valves, piping specialties, and escutcheons and access panels to be of same manufacturer throughout installation even though they may be specified in different Divisions of these specifications.
- F. All materials and equipment shall be free of asbestos. Mixes, fluxes, and solders shall be free of lead. Submit certification no asbestos or lead based materials have been used or installed.

2.02 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. All materials shall be new, unused, and delivered to the job site packed in their original containers.
- B. All materials shall be delivered free of damage or defects.
- C. Provide adequate storage facilities at the job site to protect materials from damage or corrosion.
- D. Protect material, equipment and apparatus provided under Divisions 21, 22, 23, and 26 from damage, water, dust, etc., both in storage and installed until final completion has been filed. Materials, equipment, or apparatus damaged because of improper storage or protection will be rejected and must be removed from site.

PART 3 - EXECUTION

3.01 PREPARATION

- A. The Contractor shall lay out work in advance of construction and shall determine the correct location and placement of material and equipment.
- B. Schedule work in coordination with other trades to avoid delays in construction and unnecessary cutting and patching.

3.02 INSTALLATION

- A. All work shall be installed neatly and in accordance with the best practices in the trade.
- B. Workmanship must be of highest quality, done by persons especially skilled at assigned tasks, resulting in neat, clean, and well-done installations consistent with best practices of trades.
- C. Repair or replace materials and parts of premises which become damaged as a result of installation of work of this Division. Remove replaced parts from the premises.

3.03 OPERATING AND MAINTENANCE INSTRUCTION

- A. Mechanical Instruction: Contractor shall provide instruction on the operation and maintenance of mechanical systems to maintenance personnel.
- B. Instruction shall be performed by a qualified technician.
- C. The instruction shall consist of both a "classroom" period and a "field" period.
- D. The classroom portion shall consist of a brief discussion of each piece of equipment, using the maintenance manual as a guide, and a general preventive maintenance discussion of the system as a whole. e.g., discuss procedure for maintaining proper glycol heat transfer solution mixture, etc.
- E. The field portion shall consist of a building walk-through to physically locate and examine each piece of equipment previously discussed. At that time, the main points discussed during the classroom portion shall be recovered while pointing out the specific grease fitting or valve, etc.

- F. Certification: Contractor shall submit, prior to or at the time of Substantial Completion and before the Department will accept responsibility for maintenance and operation of the facility, certification that instructions of maintenance and operation procedures have been given to representatives of the Department responsible for the maintenance and operation of the facility.
1. The certification shall indicate the name and be affixed with the signature(s) of the person(s) receiving the instructions, the dates of instruction, and the names of the Contractor or subcontractor giving the instructions and shall list the appropriate areas of instruction. Until these requirements are met, the Contractor shall provide at least one maintenance mechanic, acceptable to the Department, to operate and maintain the facility's system(s).
- G. Coordinate training requirements with Section 23 09 23 – Direct Digital Control System.
- H. Mechanical Instruction: Contractor shall provide a trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with aspects of the subject matter they are to teach and shall be approved by the Department.
- I. Provide up to 32 hours of classroom training at a Department-provided location in Haines for Department personnel. Prior to training, submit a training syllabus to the Department for approval. No training shall proceed until the training plan is approved. Provide at least 30 days' notice prior to training session. Training shall include:
1. Day One – 8 hours of training in HVAC fundamentals.
 2. Day Two – 8 hours of training in Electrical, Mechanical.
 3. Day Three – 8 hours of training in Controls and PID Control Theory and additional topics. Provide physical lab demonstrations for controls. The Department may provide locations for demonstrations of mechanical and control systems.
 4. Day Four – Site specific training including:
 - a. Explanation of drawings, operations, and maintenance manuals.
 - b. Discussion of each piece of equipment, using the maintenance manual as a guide. Explain adjustment, calibration, and replacement procedures, and discussion of system as a whole. e.g., discuss procedure for maintaining proper glycol heat transfer solution mixture, etc.
 - c. DDC operation, including:
 - 1) Location of DDC control components.
 - 2) DDC Operator workstation and peripherals.
 - 3) DDC controller and ASC operation/function.
 - 4) DDC Operator control functions including graphic generation and field panel programming.
- J. Provide 8 hours on-site training to follow up on training received in classroom. On-site training shall include a building walk-through to physically locate and examine each piece of field equipment previously discussed. At that time, the main points discussed during the classroom portion shall be recovered while pointing out the specific grease fitting or valve, etc.

3.04 START-UP / DEMONSTRATION: AS SPECIFIED IN DIVISION 01

- A. Provide the services of a factory trained technician for the start-up and testing of the following equipment:
1. Hydronic boilers.
 2. HVAC building controls.
- B. Prepare and submit complete start-up testing and demonstration plans 30 days prior to schedule test, start-up, or demonstration date. Mechanical systems shall be demonstrated for proper operation. The demonstration plan shall clearly identify each system and piece of equipment and the proposed demonstration.

- C. Following successful testing and start-up, submit certifications that the equipment and/or systems are operating properly.

END OF SECTION

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SECTION 22 05 00
BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 SUMMARY

- A. The work of this section describes the materials and methods common to sections of Divisions 22 and 23. Mechanical materials specified under sections of Divisions 22 and 23 shall meet the requirements of this Section, unless part of larger factory-assembled equipment.
- B. As specified and as shown, furnish, install, test, and place in satisfactory and successful operation equipment, materials, devices, and necessary appurtenances to provide a complete and operable mechanical system.

1.02 QUALITY ASSURANCE

- A. Mechanical Welding: Perform welding of pressure piping systems in accordance with provisions of applicable codes, including ASME Boiler and Pressure Vessel Code, and ANSI/ASME B31 Series, Code for Pressure Piping. Qualify welding procedures, welders, and operators in accordance with ANSI/ASME B31.1, Paragraph 127.5, for shop and project site welding of piping work. The performance qualifications of a welder or welding operator shall be affected under the following conditions:
 - 1. When they have not welded with a process during a period of three months or more, their qualifications for that process shall expire; except when they are welding with another process, the period may be extended to six months.
 - 2. When they have not welded with process during a period of three months, their qualifications shall expire, including those which may extend beyond three months by virtue of the above.
 - 3. Welders whose qualifications have lapsed shall be re-qualified.

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00 - Submittal Procedures and Section 22 00 00 - General Mechanical Provisions. Submittal shall list the manufacturer and shall include the following data:
 - 1. Product Data: Provide manufacturers data on expansion joints, piping supports and hangers, piping labels equipment tags, and valve tags.
 - 2. Cleaning and flushing certification: Provide certification that piping systems are cleaned, flushed, and disinfected as specified.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operation and maintenance data as specified in the individual sections of this Division and Section 01 77 00 "Contract Closeout Procedures."

1.05 COORDINATION OF ELECTRICAL AND MECHANICAL WORK

- A. Provide mechanical system controls, controllers, control transformers, disconnects, starters, control wiring, power wiring, and electrical work necessary for complete and operable mechanical systems. Motors, motor circuits, and controllers shall meet requirements of NEC 430. Electrical work including materials provided under Division 22 shall meet the requirements of Division 26. Unless otherwise specified, electrical materials and equipment included as part of larger factory-assembled equipment shall be the standard equipment normally furnished as part of that equipment by the manufacturers.

- B. HVAC Control Wiring: See Section 23 09 23 - Direct Digital Control System.
- C. Wiring Diagrams: Provide complete and approved wiring diagrams for electrical power and control work relating to mechanical systems.
- D. Install wiring for mechanical work in conduit.

1.06 CUTTING AND PATCHING

- A. Work shall be carefully laid out in advance. Where cutting, channeling, chasing, or drilling of existing surfaces is required, such work shall be carefully done. Every effort shall be made to limit damage to the existing surfaces and building subsystems. Where damage is incurred, surfaces and subsystems shall be patched and repaired to their original condition or better. Patching and repairing shall be done by skilled craftsman of the proper trades involved. Vapor barrier penetrations shall be sealed airtight. Cutting, patching, and refinishing shall comply with applicable Divisions of these Specifications. Do not cut or modify structural elements unless specifically detailed on the Drawings or approved in writing by the DEPARTMENT.

PART 2 - PRODUCTS

2.01 MOTORS AND MOTOR STARTERS FURNISHED INTEGRALLY WITH EQUIPMENT

- A. Specified in the individual Sections of this Division.

2.02 DRIVES

- A. V-belt with cast iron sheaves rated not less than 1-1/2 times motor horsepower.
- B. Motor Sheaves: Motors 5 HP and less for belt-driven equipment shall have adjustable pulleys. CONTRACTOR shall replace motor sheaves with the correct pitch diameter for motors over 5 HP to match the nameplate rating of the motor.
- C. Multiple V-belts shall be matched sets.

2.03 DRIVE GUARDS

- A. Meet requirements of OSHA.
- B. Drive guards shall be removable.
- C. Belt Drives: Enclosed in a 16-gauge expanded metal or wire screen drive guard with 70 percent free area, with steel frame covering both sides of belt drive. Provide holes in belt guards for tachometer readings. Provide access door in guard to permit checking of belt tension.
- D. Rotating Shafts and Couplings: Provide a solid 16-gauge sheet metal inverted U-cover over entire length of exposed shaft. Extend cover to below bottom of shaft and couplings.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION

- A. Follow manufacturer's recommendations.

3.02 PIPING INSTALLATION

- A. The following items are typical for piping installations:
 - 1. Close openings in pipes with appropriate caps, plugs, or covers during progress of work to prevent introduction of undesirable materials or contaminants.
 - 2. Slope pipe and provide low point drains.
 - 3. Supply hose end gate valves and high point automatic air vents.
 - 4. Provide valves and unions adjacent to tanks and equipment for isolation and removal purposes. Valves shall be installed with stems vertical whenever possible, and in no case shall stems be oriented below horizontal.
 - 5. Ream ends of pipe to full diameter free of burrs, nicks, and sharp edges.
 - 6. Cut pipe accurately from measurements taken on site. Springing or bending to fit or make up pipe shall not be permitted.
- B. Expansion Joints, Loops, Guides, and Anchors:
 - 1. Provide joints, loops, anchors, and guides as indicated on Drawings.
 - 2. Bushings shall not be permitted except on tanks and similar equipment. Close nipples shall not be permitted.
 - 3. Reduction of pipe sizes shall be made with reducing tees or reducing fittings.
 - 4. All pipe lines except piping under slab on grade shall be installed parallel with building lines and as high as possible. Piping shall clear doors, windows, and openings. Avoid ducts, light fixtures, similar equipment, and shall be concealed in finished areas whenever possible and as indicated on the Drawings.
 - 5. Piping shall be supported in a manner to prevent binding, undue swing, and vibration transmission to the structure.
 - 6. Use trapeze hangers where multiple pipes are clustered and routed in parallel.

3.03 EQUIPMENT INSTALLATION

- A. Belt Driven Equipment: Mount with motors on common steel base with adjustable motor mount. Align drives.
- B. Pumps: Align pump and motor. After steel and cast-iron pump bases are set, fill bases with concrete grout.
- C. Install equipment so manufacturer's nameplates are visible. Label equipment according to Section 22 05 53 - Identification for Plumbing Piping Equipment and verify identification tags are visible.
- D. Fan static pressures and RPM shown are approximate. Adjust or change drives as required to achieve air quantities shown.
- E. Protect installed fixtures and equipment from damage.

3.04 CLEANING

- A. During progress of the work, keep premises free of debris, cuttings, and waste material. Upon completion of work and at other times as the DEPARTMENT may direct, remove debris from premises.
- B. Remove foreign materials including dirt, grease, and splashed paint. Restore damaged finishes of equipment to original condition.
- C. Equipment, Fixtures and Devices: Components of the mechanical installation, including equipment, fixtures, and devices shall be thoroughly cleaned before final completion.

- D. Mechanical Equipment: Prior to final inspection, replace filters if heating or air conditioning units were operated during construction. If operated without filters, clean ducts, blowers, and coils.
- E. Duct Systems: Clean the interior of new duct systems prior to system operation.
- F. Water Systems: Flush piping systems, except petroleum products piping, with clear water. Operate valves and system components; drain and sterilize domestic water systems in accordance with requirements of the public health authority having jurisdiction; otherwise, use procedure specified below:
 - 1. Chlorination of Completed Lines: In general, the methods outlined in AWWA C601 entitled "Disinfection of Mains" shall be used as guide in performing this operation. Before being placed in service, the entire line shall be chlorinated. Chlorine shall be applied by the following methods: liquefied chlorine, gas-water mixture, fed-chlorine gas, or calcium hypochlorite water mixture, unless another method is approved by the DEPARTMENT. The chlorinating agent shall be applied at the beginning of each section adjacent to the feeder connection and shall be injected through a corporation cock, hydrant or other connection ensuring treatment of the entire line. Water shall be fed slowly into the line with chlorine applied in a dosage of 40 to 50 ppm. Portions of the existing mains which have been connected to a new line or otherwise contaminated by construction shall be included in the system being sterilized. A residual of not less than 10 ppm shall be produced in parts of the line at the end of a 24-hour retention period. During the chlorination process, valve operations shall be performed.
 - 2. Final Flushing: After chlorination the water shall be flushed from the lines at the extremities until the replacement water tests are equal, chemically and bacteriologically, to those of the permanent water supply. Upon completion of sterilization, certify to the DEPARTMENT in writing that the specified sterilization has been performed.
- G. Closed Hydronic Circulating Systems: After above specified flushing, draining, and refilling, boil out heating system for a period of six hours with water containing one pound Trisodium Phosphate for each 60 gallons of system capacity. Conduct boil-out procedure at a temperature not less than 194 deg F. Upon completion of boiling out, completely drain systems at low points; remove, clean, and replace strainer baskets. Flush and refill with chemically treated corrosion inhibited hydronic solution.

3.05 PAINTING AND FINISHING

- A. Ductwork and Piping: Remove scale, dirt, oil, and rust from surfaces to be painted. Prime coat angle braces, supports, hangers, rods or straps, damper rods, and quadrants with one coat of aluminum paint or rust-inhibiting primer.
- B. Ductwork, piping, mechanical equipment, and accessories exposed in finished rooms shall be painted to match room finish, unless otherwise noted. Coordinate painting and color with painting requirements and as specified in Section 09 91 23 - Interior Painting.
- C. Ductwork and piping exposed in unfinished rooms shall receive two coats of flat white paint if insulated. Uninsulated piping and fittings shall be given coats of flat black heat-resistant enamel paint over suitable rust-inhibiting primer.
- D. Mechanical equipment and accessories exposed in unfinished rooms shall be factory prime coated and finished with manufacturers' standard colors.
- E. Do not paint bronze body valves.
- F. Mechanical Rooms, Fan Rooms, and Equipment Rooms: Exposed piping in the mechanical rooms, fan rooms, and equipment rooms shall be finish painted and color coded as specified. Where piping is finish painted, fluid identification and flow direction arrows shall be applied.

- G. Exposed Mechanical Equipment: Mechanical equipment exposed in finished rooms or visible on the building exterior shall be factory prime coated and field finished in accordance with color scheme requirements, unless of stainless-steel or aluminum construction.
- H. Exterior items of aluminum construction shall be anodized or factory finished in color as selected by the DEPARTMENT. The selection of anodized versus colored finish shall be the option of the DEPARTMENT.

3.06 PRELIMINARY OPERATION

- A. Operate portions of installation if requested. Such operation does not constitute acceptance of the work as complete.

3.07 START-UP / DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation of mechanical systems.

END OF SECTION

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes valves for plumbing systems.

1.02 REFERENCES

- A. ANSI-61-8-G - Lead Content Evaluation Procedure (Lead-free 0.25 percent Pb max + chemical/organics requirements of ANSI/NSF 61 Section 8).
- B. ANSI-372 – Drinking Water System Components – Lead Content (Lead-free 0.25 percent Pb max only).
- C. NSF/ANSI 61 Section 8 – Drinking Water System Components – Mechanical Devices (Low Lead and chemical/organics leaching test).
- D. ANSI-Z21.22 (American National Standards Institute) - Relief Valves and Automatic Gas Shut off Devices for Hot Water Supply Systems.
- E. ASME B16.3 (American Society of Mechanical Engineers) - Malleable Iron Threaded Fittings.
- F. AWS (American Welding Society) - Welding and Brazing Qualifications.
- G. MSS SP-67 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Butterfly Valves.
- H. MSS SP 70 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Gate Valves, Flanged and Threaded Ends.
- I. MSS SP-71 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- J. MSS SP-78 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Plug Valves, Flanged and Threaded Ends.
- K. MSS SP-80 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Bronze Gate, Globe, Angle and Check Valves.
- L. MSS SP-85 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.
- M. MSS SP-110 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit Manufacturers catalog information with valve data and ratings for each service.

- C. Welder's Certificate: Include welder's certification of compliance with ASME SEC IX.
- D. Manufacturer's Installation Instructions: Submit hanging and support methods joining procedures.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit product data, installation instructions, spare parts lists, and exploded assembly views.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Alaska standard.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 - Material and Equipment for product storage and handling requirements.
- B. Accept valves on-site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Valves shall not be installed underground when bedding is wet or frozen.

PART 2 - PRODUCTS

2.01 ISOLATION VALVES

- A. Larger than 4 Inches: Gate valves.
 - 1. Manufacturers: Nibco, Milwaukee, or equal.
 - 2. Provide MSS SP-70, Class 125 WSP, 200 psi WOG, iron body, bronze trim, outside screw and yoke, hand-wheel, solid wedge disc, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor, lead free with wetted surfaces of components containing less than 0.25 percent of lead by weight, or
 - 3. Provide PVC or CPVC body, gate, stem, and connectors meeting ASTM 1784. Nonrising stem, stainless steel, PVC, or CPVC bonnet, Buna-N, viton, or neoprene seals. Pressure rating of 150 psi.

- B. 4 Inches and Smaller: Ball valves.
 - 1. Manufacturers: Nibco, Milwaukee, or equal.
 - a. Provide MSS SP-110, Class 150 WSP, 400 psi WOG, bronze, two-piece body, chrome plated brass ball, full port ball, teflon seats and stuffing box ring, blow-out proof stem, lever handle, solder or threaded ends, or
 - b. Provide MSS SP-122, PVC or CPVC body, stem, ball, and unions meeting ASTM 1784. PTFE seats and neoprene or viton seals, EPDM shall not be used. Socket ends conforming to ASTM F439 or ASTM D2446 and D2467. Pressure rating of 150 psi.
 - 2. Lead-free, with wetted surfaces of components containing less than 0.25 percent of lead by weight.

2.02 BALANCING VALVES

- A. Manufacturer: Armstrong CBV Balance Valves, Bell & Gossett Circuit Setter Plus Calibrated Balance Valves, or equal.
- B. Provide calibrated positive shut-off balancing valves with, tamper proof memory stop that locks valve position, connections for a portable differential pressure meter, and integral pointer to indicate valve setting.
- C. Lead-free, with wetted surfaces of components containing less than 0.25 percent of lead by weight.
- D. Each valve shall be furnished with a pre-formed, removable PVC insulation jacket.

2.03 FLOW CONTROL VALVES

- A. Manufacturers: Griswold Controls, Bell & Gossett, or equal.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet.
- C. Lead-free with wetted surfaces of components containing less than 0.25 percent of lead by weight.
- D. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times pressure required for control; maximum valve pressure drop: 1.0 psi.
- E. Control Mechanism: Stainless steel or nickel-plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- F. Accessories: In-line strainer on inlet and ball valve on outlet.

2.04 SWING CHECK VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.
- B. 2 Inches and smaller: MSS SP-80, Class 150 WSP 300 WOG, bronze body, seat, and cap, bronze swing disc holder, composition disc, solder or threaded ends.
- C. Larger than 2 Inches: MSS SP-71, Class 125, cast iron body, bronze swing disc, renewable disc seal and seat, flanged ends.
- D. Lead-free, with wetted surfaces of components containing less than 0.25 percent of lead by weight.

2.05 SPRING LOADED CHECK VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.
- B. Construction: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.
- C. Lead-free, with wetted surfaces of components containing less than 0.25 percent of lead by weight.

2.06 RELIEF VALVES

- A. Temperature and Pressure Relief:
 - 1. Manufacturers: Nibco, Watts, or equal.
 - 2. Construction: ANSI Z21.22 certified, bronze body, Teflon seat, stainless steel stem and springs, automatic, direct-pressure-actuated, temperature relief maximum 210 deg F, capacity ASME SEC IV certified and labeled.
 - 3. Lead-free, with wetted surfaces of components containing less than 0.25 percent of lead by weight.

2.07 COMBINATION AIR-VACUUM AND AIR-RELEASE VALVES:

- A. Combination Air Valves: AWWA C512, ANSI/NSF 61, ductile iron body, all internal components shall be 316 stainless steel, resilient seat capable of sealing from 1 psi to the maximum working pressure, 150 psi cwp, epoxy lined and coted conforming to AWWA C550.

2.08 BUTTERFLY VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- C. Lead-free, with wetted surfaces of components containing less than 0.25 percent of lead by weight.
- D. Disc: Aluminum bronze or chrome plated ductile iron.
- E. Operator: 10-position lever handle or electric actuator.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. See Division 01 for coordination and project conditions.
- B. Verify piping system is ready for installation.
- C. All plumbing water system valves shall be lead-free, meeting the "Reduction of Lead in Drinking Water Act" requirements, with wetted surfaces of components containing less than 0.25 percent of lead by weight.

3.02 INSTALLATION

- A. Provide non-conducting dielectric union or isolating flange connections wherever jointing dissimilar metals.

- B. Install valves with stems upright or horizontal, not inverted.
- C. Use grooved mechanical couplings and fasteners only in accessible locations.
- D. Install unions downstream of valves and at equipment or apparatus connections. Direct welded or threaded connections to valves, equipment or other apparatus shall not be utilized.
- E. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- F. Install globe or ball valves for throttling, bypass, or manual flow control services.
- G. Provide spring loaded check valves on discharge of water pumps.
- H. Provide flow controls in water re-circulating systems as indicated on Drawings.
- I. Use 3/4-inch gate or ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Conform to applicable piping specification for hangers and insulation.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes pipe and equipment supports, hangers, anchors, bases, sleeves, and sealing of work to adjacent construction.

1.02 REFERENCES

- A. ASME B31.5 (American Society of Mechanical Engineers) - Refrigeration Piping.
- B. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.
- C. AWS D1.1 (American Welding Society) - Structural Welding Code - Steel.
- D. MSS SP58 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- E. MSS SP69 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP89 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. NFPA 13 (National Fire Protection Association) - Installation of Sprinkler Systems.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 - Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data: Submit manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipes, and riser support hangers.
- E. Manufacturer's Installation Instructions: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with International Building Code, International Mechanical Code, and the Uniform Plumbing Code for piping support.
- B. Perform work in accordance with ASME B31.9 and AWS D1.1 for welding hanger and support attachments to building structure.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years of experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years of experience.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Grinnell, B-Line Systems, Inc., or approved equal.
- B. Plumbing Piping - DWV:
 - 1. Conform to ASME B31.9, MSS SP58, MSS SP69, and MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2- to 1-1/2 Inch: Malleable iron or carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Pipe Sizes 2 Inches 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 Inches: Cast iron hook.
 - 6. Wall Support for Pipe Sizes 4 Inches 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: Spiral wrap pipe with UPC approved 10 mil PVC pipe wrap; provide a minimum of two (2) layers.
- C. Plumbing Piping - Water:
 - 1. Conform to ASME B31.9, MSS SP58, MSS SP69, and MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2- to 1-1/2 inch: Malleable iron or carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 inches and over: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 6. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 7. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 8. Vertical Support: Steel riser clamp.
 - 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 10. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 11. Copper Pipe Support: Spiral wrap pipe with UPC approved 10 mil PVC pipe wrap; provide a minimum of two (2) layers.

2.02 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.03 INSERTS

- A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

- A. Metal Flashing: 26-gauge thick galvanized steel.
- B. Metal Counterflashing: 22-gauge thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb./sq. ft. sheet lead.
 - 2. Soundproofing: 1 lb./sq. ft. sheet lead.
- D. Flexible Flashing: 47 mil thick sheet compatible with roofing.
- E. Caps: Steel, 22 gauge minimum; 16 gauge at fire-resistant elements.

2.05 EXPANSION JOINTS AND GUIDES

- A. Pipe Anchors: Shall be Keflex-Mave BA or equal copper for copper pipe.
- B. Pipe Guides: Shall be Keflex-Mave, Type BC or equal copper for copper pipe.
- C. Pipe Anchors: Shall be welded steel. Submit shop drawings.

2.06 SLEEVES

- A. Sleeves for Pipes through Non-Fire-Rated Floors: 18-gauge thick galvanized steel.
- B. Sleeves for Pipes through Non-Fire-Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18-gauge thick galvanized steel.
- C. Sleeves for Pipes through Fire-Rated and Fire-Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel.
- F. Fire-Stopping Insulation: Glass fiber type, non-combustible.
- G. Sealant: Acrylic.

PART 3 - EXECUTION

3.01 INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.02 PIPE HANGERS AND SUPPORTS

- A. Hangers and supports shall have a minimum safety factor of five based upon ultimate tensile strength or compressive strength, as applicable of the material used. Turnbuckles shall have the capacity of not less than the attached rod.
- B. Support horizontal piping per the most recent adoption of the International Plumbing Code for the system materials specified.
- C. Chain or strap hangers (plumber tape) shall not be permitted.
- D. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.
- E. Place hangers within 12 inches of each horizontal elbow.
- F. Use hangers with 1-1/2-inch minimum vertical adjustment.
- G. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- H. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- I. Provide bracing to prevent lateral movement.
- J. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- K. Weight of piping from mechanical equipment, pump flanges, coil connections, and related items shall not be supported.
- L. Support riser piping independently of connected horizontal piping.
- M. Provide insulated shields between hangers or supports for insulated piping systems.
- N. Provide copper plated hangers and supports for copper piping and sheet lead packing between hanger or support and steel piping.
- O. Design hangers for pipe movement without disengagement of supported pipe.
- P. Prime coat exposed steel hangers and supports.
 - 1. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.03 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00 - Cast-in-Place Concrete.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.04 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. 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.
- C. Flash floor drains in floors with topping over finished areas with lead; 10 inches clear on sides with minimum 36- by 36-inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, shower, and mop sink drains watertight to adjacent materials.
- E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- F. 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.

3.05 SLEEVES

- A. Set sleeves in position in forms. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.06 SCHEDULES

Pipe Size	Maximum Hanger Spacing	Rod Diameter
1/2-inch to 1-1/4 inch	Per Latest IPC	3/8-inch
1-1/2-inch to 2-inch	Per Latest IPC	3/8-inch
2-1/2-inch to 3 inch	Per Latest IPC	1/2-inch
4-inch and over	Per Latest IPC	5/8-inch
Case-Iron (All Sizes)	Per Latest IPC	1/2-inch

3.07 START-UP/DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 General Mechanical Provisions.
- B. The CONTRACTOR shall demonstrate, to the satisfaction of the DEPARTMENT, the complete and proper support of piping systems. The demonstration shall include, but is not limited to the following:

1. Proper installation and support of piping systems, including the installation of sleeves, seismic bracing, anchors, and expansion joints.

END OF SECTION

SECTION 22 05 48
VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes inertia bases and vibration isolation.

1.02 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping.
- B. Provide minimum static deflection of isolators for equipment as follows:
 - 1. Under 400 rpm: 3.5-inch.
 - 2. 400 - 600 rpm: 3.5-inch.
 - 3. 600 - 800 rpm: 2-inch.
 - 4. 800 - 900 rpm: 1-inch.
 - 5. 1100 - 1500 rpm: 0.5-inch.
 - 6. Over 1500 rpm: 0.2-inch.
- C. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
- D. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook.
 - 1. Shops: OSHA.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 - Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Shop Drawings: Locate vibration isolators with static and dynamic load on each indicated assembly. Provide material, thickness, dimensional data, pressure loss, acoustical performance, layout, and connection details for sound attenuation products fabricated for this project.
- C. Product Data: Submit schedule of vibration isolator type with location and load. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Design Data: Provide sealed engineering calculations of seismic restraints, bracing, and equipment anchor designs. Detailed calculations shall show the weight distribution for equipment supports and the loads at the vibration isolators.
- E. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.
- F. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- G. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 22 00 00 - General Mechanical Provisions.

- B. Project Record Documents: Record install locations of hangers including attachment points.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with AMCA 300 standards and recommendations of ASHRAE 68.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.07 SEISMIC CONTROL

- A. Central equipment, machinery, tanks, and hereafter listed vibration isolation equipment shall be fitted with seismic restraint systems in accordance with FEMA 412 to resist seismic forces per SEI/ASCE 7-02. Refer to the general structural notes listed on the contract drawings for applicable seismic design data regarding spectral accelerations, site class, importance factor, and seismic use group. Such items shall be as engineered, designed, and manufactured by Mason Industries, Inc., Anaheim, CA, or approved equal. Stamped calculations and product data shall be submitted for evaluation and approval.
 - 1. Air Compressors.
 - 2. Base Mounted Pumps.
 - 3. In-Line Pumps.
 - 4. Oil Water Separator.
 - 5. Tanks.
 - 6. Water Heaters.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Open Spring Isolators:
 - 1. Spring Isolators:
 - a. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25-inch-thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05-inch; meet requirements for neoprene pad isolators.
- B. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Spring Mounts: Furnish with leveling devices, minimum 0.25-inch-thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05-inch; meet requirements for neoprene pad isolators.
 5. Restraint: Furnish mounting frame and limit stops.
- C. Closed Spring Isolators:
1. Spring Isolators:
 - a. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25-inch clearance.
- D. Restrained Closed Spring Isolators:
1. Spring Isolators:
 - a. Code: Color-code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25-inch clearance and limit stops.
- E. Spring Hanger:
1. Spring Isolators:
 - a. Code: Color-code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 4. Misalignment: Capable of 20-degree hanger rod misalignment.
- F. Neoprene Pad Isolators:
1. Rubber or Neoprene-Waffle Pads:
 - a. Minimum 3/8-inch thick.
 - b. Maximum loading 60 psi.
 - c. Height of ribs: not to exceed 0.7 times width.
 2. Configuration: Single layer.
- G. Neoprene Mountings: Molded oil-resistant neoprene designed for 0.25-inch deflection with threaded insert.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. See Division 01: Coordination and project conditions.

- B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.02 INSTALLATION

- A. Vibration isolator sizes shall be determined by the isolator manufacturer and shall be installed in accordance with the manufacturer's instructions.
- B. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- C. Install isolation for motor driven equipment.
 - 1. Bases:
 - a. Set steel bases for 1-inch clearance between housekeeping pad and base.
 - b. Adjust equipment level.
 - 2. Install spring hangers without binding.
- D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- E. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.
- F. Provide vibration hangers to support piping and ductwork runs within the first 50 feet nearest the connection to rotating equipment and or isolated equipment.
 - 1. Select three hangers closest to vibration source for minimum 1.0-inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0-inch static deflection or 1/2 static deflection of isolated equipment.
- G. Connect wiring to isolated equipment with flexible hanging loop.
- H. Mechanical equipment shall be carefully checked upon delivery for proper mechanical performance which shall include proper noise and vibration operation.
- I. Installed rotating equipment with excessive noise and/or vibration which cannot be corrected in place shall be replaced at no cost to the Department.
- J. Vibrating equipment and the interconnecting pipe and ductwork shall be isolated to eliminate the transmission of objectionable noise and vibration from the structure.
- K. Mount or suspend equipment and piping from approved foundations and supports, as shown.
- L. Erect floor mounted equipment on minimum 4-inch-high concrete pads over the complete floor area of the equipment, unless shown otherwise. Wherever vibration eliminating devices are specified, these items shall be mounted on minimum
- M. 4-inch-high concrete pads, unless shown otherwise. Pour concrete pads directly on or with the structural slab except where inertia blocks are required and shown.

3.03 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.

- B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

3.04 SCHEDULES

EQUIPMENT ISOLATION SCHEDULE

ISOLATED EQUIPMENT	ISOLATOR TYPE
In-Line Pumps	Open spring hanger with seismic cable restraint
Base-Mounted Equipment, Air Compressors, and Pumps	Restrained open spring mount

3.05 START-UP/DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. The Contractor shall demonstrate to the satisfaction of the Department the complete and proper operation of systems. The demonstration shall include, but is not limited to the following:
1. Proper operation of vibration isolation, and sound attenuation equipment.
- C. Seismic restraint and proper anchoring of mechanical systems.

END OF SECTION

**SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes nameplates, tags, and pipe markers.

1.02 REFERENCES

- A. ASME A13.1 (American Society of Mechanical Engineers) - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record installed locations of tagged valves; include valve tag numbers.

1.05 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 NAMEPLATES

- A. Manufacturers: Seton Identification Products, Brady, or approved equal.
- B. Product Description: Bemis Lamicoid, Laminated three-layer plastic with engraved letters on light contrasting background color.

2.02 TAGS

- A. Plastic Tags:
 - 1. Manufacturers: Seton Identification Products, Brady, or approved equal.
 - 2. Bemis Lamicoid, Laminated three-layer plastic with engraved letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- B. Metal Tags:
 - 1. Manufacturers: Seton Identification Products, Brady, or approved equal.
 - 2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- C. Information Tags:
 - 1. Manufacturers: Seton Identification Products, Brady, or approved equal.
 - 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.03 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers: Seton Identification Products, Brady, or approved equal.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers:
 - 1. Manufacturers: Seton Identification Products, Brady, or approved equal.
 - 2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.04 LABELS

- A. Manufacturers: Seton Identification Products, Brady, or approved equal.
- B. Description: Aluminum, size 1.9 by 0.75 inches, adhesive backed with printed identification.

PART 3 - EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A. General:
 - 1. Install identifying devices after completion of coverings and painting.
 - 2. Install plastic nameplates with corrosive-resistant mechanical fasteners or adhesive.
 - 3. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. Apply paint primer before applying labels to unfinished canvas coverings.

4. Install tags using corrosion resistant chain. Number tags consecutively by location.
- B. Piping:
1. Identify piping, concealed or exposed, with approved color-coded adhesive bands and indicate fluid type and flow direction. Directional arrows shall black and not less than 1 inch long on same background as symbols.
 2. Identify piping at approximately 15-foot centers in rooms, adjacent to each valve and tee, as well as in the other spaces (such as shafts) in which piping may be viewed. There shall be at least one set of identifying bands per pipe in each space requiring identifying bands. In addition, the origination of each pipe main shall be further identified indicating the zone served.
 3. Bands shall be applied where they can be easily read and with their long dimension parallel to the axis of the pipe.
- C. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- D. Valves:
1. Identify valves in areas with 1-1/2-inch by 3-inch Bemis Lamicoid identification tags installed on handwheels or stem with brass bead chain. Engrave identification tags indicating the service abbreviation and stating whether normally open (engraved on green) or normally closed (engraved on red).
 2. Service abbreviation shall match pipe coding. In addition, each valve tag shall include a unique sequential identification number.
- E. Equipment:
1. Provide manufacturer's nameplates on equipment identifying manufacturer's: name, model number, size, capacity, electrical characteristics, etc.
 2. Leave manufacturer's nameplates clean and legible and visible. Install nameplates visible from normal path of equipment access.
 3. Further identify equipment with engraved Lamicoid identification tags secured to equipment. Identification shall conform to the equipment designation scheduled on the drawings. Securely fasten identification tags to equipment.
 - a. Equipment includes:
 - 1) Air Compressor.
 - 2) Air Dryer.
 - 3) Expansion Tanks.
 - 4) Hose Reels.
 - 5) Oil Water Separator.
 - 6) Pressure Tank.
 - 7) Pumps.
 - 8) Water Heaters.
- F. Controls: Provide engraved Lamicoid identification tag of function on switches, controllers and manually operable or adjustable controls. Tag automatic controls, instruments, and relays. Provide key to control schematic.
- G. Identification Charts: Provide charts framed with glass or plastic front. Pipe identification chart shall list piping systems with symbol and color coding where applicable. Valve identification chart shall list valve model numbers and symbol for service corresponding to piping symbol. Mount identification charts in each mechanical area.

- H. Controllers: Provide nameplates in accordance with Section 26 05 33 Identification for Electrical Systems.

3.03 SCHEDULES

PIPE IDENTIFICATION SCHEDULE

Service	Abbreviation	Label Color	
		Background	Text
Cold Water	CW	Green	White
Hot Water	HW	Green	White
Tempered Water	TEMPERED	Green	White
Vent	VENT (V)	White	Black
Waste	WASTE (W)	Orange	Black
Pumped Waste	PUMPED W	Orange	Black
Pumped Treated Waste	TREATED W	Green	White
Compressed Air	AIR	Blue	White

3.04 START-UP/DEMONSTRATION:

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of systems. The demonstration shall include, but not be limited to the following:
1. Adequate piping-finish, painting, and labels.
 2. Proper piping, valve, equipment tags, and identifications charts are installed on equipment and are in each mechanical space.

END OF SECTION

SECTION 22 05 95
TESTING PLUMBING PIPING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. The work of this section consists of testing building piping systems to ensure they are complete, operable, and ready for use.

1.02 QUALITY ASSURANCE

- A. Notify DEPARTMENT at least 96 hours before testing.
- B. Provide test equipment including test pumps, gauges, instruments, and other equipment required. Pressure gauges shall be graduated in increments not greater than 5 psi and shall have range of approximately twice test pressure. Use only gauges and instruments recently calibrated.

1.03 SUBMITTALS

- A. Submit system testing plans and final certifications that systems pass the testing requirements specified hereinafter.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Conduct tests in the presence of the contracting officer and/or owner's representative, who shall be given 96 hours' notice before test is to be conducted. Provide water and electricity required for the tests. Determine that dampers, registers, and valves are in a set or fully open position.

3.02 PIPING

- A. Test before concealing piping. Before testing, isolate or remove equipment from system that would be damaged by test pressure. Purge or bleed air from piping systems before performing hydrostatic testing. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system. Test time shall be accrued only while full test pressure is on system. Replace removed equipment after testing.
- B. No loss of pressure shall be allowed. Repair leaks found during tests by rewelding or replacing pipe or fittings. Caulking of joints shall not be permitted. Makeshift remedies shall not be permitted.

- C. Perform hydrostatic or pneumatic tests on piping in accordance with the following schedule. Maintain pressure for at least 24 hours. Perform tests in the presence of the DEPARTMENT. Unless otherwise specified below, tolerances for tests shall be no pressure drop, except that due to temperature change. Testing shall include exterior fuel and secondary containment lines from tanks to the buildings.

<u>System</u>	<u>Test Medium</u>	<u>Test Pressure</u>	<u>Tolerance</u>
Water Piping Systems	Water	80 psig	No leaks / 2 hours
Pumped Waste	Water	10-foot head or top of vent	No leaks / 2 hours
Pumped Treated Water and Vent	Water	10-foot head or top of vent	No leaks / 2 hours
Soil and Waste Vents	Water	10-foot head or top of vent	No leaks / 2 hours
Fuel Oil Piping		Test per NFPA 31	
Shop Air	Air	250 psig	No leaks / 2 hours

3.03 PIPING SPECIALTIES

- A. Test thermometers, pressure gauges, and water meters for accurate indication.
- B. Verify proper operation of automatic water feeders, air vents, and vacuum breakers.
- C. Test air vent points to ensure air has been vented.

3.04 VALVES

- A. Check valve bonnets for tightness and external leaks. Test manual and solenoid operated valves from closed-to-open-to-closed position while valve is under test pressure.
- B. Test automatic valves, including expansion, water regulating, pressure reducing, pressure relief, safety, and temperature and pressure relief valves at settings shown on the drawings or specified in the individual sections.
- C. Test pressure relief, safety, and temperature and pressure relief valves three times.

3.05 EQUIPMENT TESTS

- A. Upon completion of installation, but before applying power to any operating equipment or package control system, obtain the services of respective manufacturer's representative to inspect and witness trial runs of equipment. Inspection shall include alignment, direction of rotation, initial lubrication, RPM, voltage, amperage, and nameplate data.

3.06 HANGERS AND SUPPORTS

- A. With system in normal operation, test hangers, supports, and rods to ensure they are plumb and supporting proper share of load. Additionally, support systems and equipment that sway, crawl, or vibrate.

3.07 EXPANSION TANKS

- A. Check proper water level when system is at working pressure and temperature.
- B. Check proper pre-charge pressure prior to installation.

3.08 OTHER MATERIALS AND EQUIPMENT

- A. Test other piping specialties, materials, and equipment as specified, as recommended by equipment manufacturer, or as directed.

3.09 CERTIFICATION

- A. CONTRACTOR shall submit a statement certifying that tests were performed in accordance with the requirements of the Specifications and that no leaks and/or deficiencies were found or detected. The certification shall include the name of the company, date of testing, name and signature of the person performing the test, and verification by the DEPARTMENT.

END OF SECTION

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**SECTION 22 07 00
PLUMBING INSULATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Insulation jackets,
 - 2. Equipment insulation,
 - 3. Piping system insulation, and
 - 4. Insulation accessories including vapor retarders, jackets, and accessories.

1.02 REFERENCES

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- E. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- F. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- G. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.
- H. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- K. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- L. NAIMA (North American Insulation Manufacturers Association) - National Insulation Standards.
- M. SMACNA (Sheet Metal and Air Conditioning Contractors National Association) - HVAC Duct Construction Standard Metal and Flexible.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit product description, thermal characteristics, and list of materials and thickness for each service and location.

- C. Manufacturer's Installation Instructions: Submit manufacturers' published literature indicating proper installation procedures.

1.04 QUALITY ASSURANCE

- A. Composite insulation including jackets, coverings, sealers, mastics, and wet or dry adhesives shall have a flame-spread rating of 25 or less and smoke-developed rating of 50 or less—as tested by ASTM E84. Tubing insulation with a smoke-developed rating of 150 or less may be used on refrigeration lines. PVC fitting covers shall have a maximum flame spread of 25 or less and are excluded from the smoke spread criteria.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Material and Equipment for product storage and handling requirements.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, and including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage by storing in original wrapping.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 FIBROUS GLASS PIPE INSULATION

- A. Factory-molded fibrous glass with factory-applied all-service jackets, ASTM C547 Type I. Maximum thermal conductivity (k): 0.23 B-in/hr-ft²-°F at 75 deg F mean, Insulation shall be Micro-Lok HP manufactured by Johns-Manville Corporation, Denver, Colorado; SSL II with ASJ Max manufactured by Owens Corning, Toledo, Ohio or approved equal. Insulation exposed to the weather or physical damage shall be metal-jacketed, 650 ML.

2.02 PIPE FITTING AND VALVE COVERS

- A. One-piece compressed fibrous glass blanket and premolded PVC cover; thickness shall be equal to adjoining pipe insulation. Provide PVC covers for tees, 45-degree elbows, 90-degree elbows, and valve stems.

- B. Fittings where PVC cover does not work shall be covered with spiral-wrapped glass mesh and finished with 1/16-inch-thick mastic coating.
- C. Provide layered closed cell insulation blankets on exterior water pipe, grooved couplings, and valves with thickness to match adjacent arctic pipe.

2.03 PIPE INSULATION ACCESSORIES

- A. Rigid Insulation Inserts for Pipe: Calcium silicate, or approved equal, for installation between pipe and hanger. Provide cellular foam inserts for cold piping systems below 60 deg F working fluid temperature. Insulation inserts shall be not less than 6 inches long for 1-1/2-inch to 2-1/2-inch pipe, and 9 inches long for 3-inch to 6-inch pipe; thickness shall be equal to adjoining insulation.
- B. Rigid Insulation Inserts for Tube: Shall be J. M. Aerotube rigid insulation, as manufactured by Johns-Manville Corporation, Denver, Colorado; K-flex 360 manufactured by K-Flex USA, Youngsville, North Carolina; or approved equal.
- C. Galvanized Metal Shields: 16 gauge for 3-inch and smaller pipe, and 14 gauge for 4-inch and larger; formed to fit the diameter of the insulation, extending up to the centerline of the pipe. Length shall be equal to insulation hanger inserts.

2.04 PIPE INSULATION ADHESIVES, SEALANTS, AND VAPOR BARRIER MASTICS

- A. Foster, 3M, or approved equal. For tubing insulation, use products recommended by manufacturer.

2.05 PIPE INSULATION METAL JACKETS

- A. Aluminum Jacket: ASTM B209, 0.016-inch thick sheet thick with embossed finish, joint with longitudinal slip joints and 2-inch laps.
 - 1. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
 - 2. Metal Jacket Bands: 3/8-inch-wide; 0.015-inch-thick aluminum.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Exposed Piping: Locate insulation and cover seams in least visible locations.
- B. Insulated pipes conveying fluids below indoor ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- C. Man-made-mineral-fiber-insulated pipes conveying fluids below ambient temperature:
 - 1. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive, self-sealing longitudinal laps, and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers. Ensure

continuous vapor retarder to prevent condensation build up on piping; no exposed insulation at wall or floor penetrations. Seal insulation ends vapor tight at all breaks in continuous insulation.

- D. For hot piping conveying fluids over 140 deg F insulate flanges and unions at equipment.
- E. Man-made-mineral-fiber-insulated pipes conveying fluids above ambient temperature:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 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.
- F. Inserts and Shields:
 - 1. Application: Piping or Equipment 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 finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
- G. 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 - Firestopping for penetrations of assemblies with fire resistance rating greater than 1 hour.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces. Finish with PVC jacket and fitting covers or aluminum jacket within 8ft of floor.
- I. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with 316 stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.
- J. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1-mil-thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.
- K. Factory Insulated Equipment: Shall not be additionally insulated.
- L. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- M. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- N. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment use vapor retarder cement.
- O. Mineral fiber insulated equipment containing fluids below ambient temperature: Provide vapor retarder jackets, factory-applied or field-applied, and finish with glass-cloth and vapor barrier adhesive.
- P. For equipment containing fluids over 140 deg F insulate flanges and unions with removable sections and jackets.

- Q. Mineral fiber insulated equipment containing fluids above ambient temperature: Provide standard, factory-applied or field-applied, jackets with or without vapor retarder and finish with glass cloth and adhesive.
- R. Finish insulation at supports, protrusions, and interruptions.
- S. Equipment in mechanical equipment rooms or finished spaces: Finish with canvas jacket sized for finish painting or PVC jacket and fitting covers.
- T. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- U. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- V. Exterior Applications: Provide insulation with vapor retarder jacket. Cover with caulked anodized aluminum jacket with seams located on bottom side of horizontal duct section.

3.03 SCHEDULES

- A. Pipe Insulation:
 - 1. Domestic Hot, Cold, and Tempered Water, Pipe Sizes: Fiberglass, 2 inches thick.
 - 2. Plumbing Vents, 3 Feet below Roof Insulation to Termination above Roof Line: Fiberglass, 2 inches thick.
 - 3. Piping Subject to Freezing Ambient Temperatures, Pipe Sizes: Fiberglass, 2 inches thick.
 - 4. Hot Equipment: Fiberglass, 2 inches thick.

END OF SECTION

SECTION 22 08 00
COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plumbing commissioning description.
 - 2. Plumbing commissioning responsibilities.
- B. Related Sections:
 - 1. Section 01 91 00 - Commissioning.
 - 2. Section 23 08 00 - Commissioning of HVAC: HVAC systems commissioning requirements.

1.2

- A.

1.3 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE Guideline 1 - The HVAC Commissioning Process.
- B. Building Commissioning Association:
 - 1. BCA - Commissioning Handbook.
- C. National Environmental Balancing Bureau:
 - 1. NEBB - Procedural Standards for Building Systems Commissioning.
- D. Testing Adjusting and Balancing Bureau:
 - 1. TABB - Commissioning Manual.

1.4 COMMISSIONING

- A. Plumbing commissioning process includes the following tasks:

1. Testing and startup of plumbing equipment and systems. Equipment and
 2. system verification checks.
 3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
 4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
 5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
 6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
 7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
 8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
 9. Provide training for systems specified in this Section with coordination by Commissioning Authority.
- B. Equipment and Systems to be Commissioned:
1. New plumbing systems that were installed under this Contract.
- C. The following is a partial list of equipment that may be included in this Plumbing Commissioning:
1. Compressed air system.

1.5 COMMISSIONING

- A. Buy American Compliance
1. All submittals shall include a manufacturer or supplier certification or other evidence that products meet Buy America Preference requirements of the project. This may include evidence the product was submitted in an approved Type 3 or Type 4 waiver request prior to contract award. Submittals without the certification or other evidence indicating compliance will be rejected without further review.
- B. Section 01 91 00 - Commissioning: Requirements for commissioning submittals.

- C. Draft Forms: Submit draft of system verification form and functional performance test checklist.
- D. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.
- E. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.6 CLOSEOUT SUBMITTALS

- A. GCP 60-08 - Submittal Procedures: Requirements for submittals.
- B. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.
- C. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with Section 01 91 00.

1.8 COMMISSIONING

- A. Equipment or System Installer Commissioning Responsibilities:
 - 1. Attend commissioning meetings.
 - 2. Ensure controls installer performs assigned commissioning responsibilities as specified below.
 - 3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
 - 4. Provide instructions and demonstrations for Owner's personnel.
 - 5. Ensure subcontractors perform assigned commissioning responsibilities.
 - 6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
 - 7. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned. If manufacturer's startup procedures are not available, provide in accordance with accepted industry practice.

8. During verification check and startup process, execute plumbing related portions of checklists for equipment and systems to be commissioned.
9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
10. Provide representatives experienced with operation of equipment to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Perform verification checks and startup on equipment and systems as specified.
16. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
17. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
18. Conduct plumbing system orientation and inspection.

1.9 COMMISSIONING

- A. Section 01 91 00 - Commissioning: Requirements for commissioning meetings.
- B. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.10 COORDINATION

- A. GCP 50 Control of Work: Requirements for coordination.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Place plumbing systems and equipment into full operation and continue operation during each working day of commissioning.

END OF SECTION

SECTION 22 11 00
FACILITY WATER DISTRIBUTION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes domestic water system, piping, fittings, valves, hot water tempering station, specialties, and accessories.

1.02 REFERENCES

- A. ANSI-61-8-G - Lead Content Evaluation Procedure (Lead-free 0.25 percent Pb max + chemical/organics requirements of ANSI/NSF 61 Section 8).
- B. ANSI-372 – Drinking Water System Components – Lead Content (Lead-free 0.25 percent Pb max only).
- C. NSF/ANSI 61 Section 8- Drinking Water System Components – Mechanical Devices (Low Lead and chemical/organics leaching test).
- D. ANSI Z21.22 - Relief Valves for Hot Water Supply Systems.
- E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- G. ASME B31.9 - Building Services Piping.
- H. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
- I. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
- J. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- K. ASSE 1010 (American Society of Sanitary Engineering) – Performance Requirements for Water Hammer Arresters.
- L. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
- M. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Principle Backflow Preventers.
- N. ASME A112.26.1 (American Society of Mechanical Engineers) - Water Hammer Arresters.
- O. ASME B16.18 (American Society of Mechanical Engineers) - Cast Copper Alloy Solder Joint Pressure Fittings.
- P. ASME B16.22 (American Society of Mechanical Engineers) - Wrought Copper and Bronze Solder Joint Pressure Fittings.
- Q. ASME B31.9 (American Society of Mechanical Engineers) - Building Service Piping.
- R. ASSE 1010 (American Society of Sanitary Engineering) – Water Hammer Arrestors.

- S. ASSE 1018 (American Society of Sanitary Engineering) – Automatic Trap Seal Priming Valves.
- T. ASTM B32 - Standard Specification for Solder Metal.
- U. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
- V. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- W. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- X. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
- Y. AWWA C651 (American Water Works Association) - Disinfecting Water Mains.
- Z. AWWA C700 - Cold-Water Meters - Displacement Type, Bronze Main Case.
- AA. Manufacturers Standardization Society of the Valve and Fittings Industry:
 - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 2. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
 - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
 - 4. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- BB. National Sanitation Foundation – NSF-61-G.
- CC. PDI WH-201 (Plumbing and Drainage Institute) - Water Hammer Arrestor.
- DD. UL 1479 (National Fire Protection Association) - Fire Tests of Through-Penetration Fire Stops.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data:
 - 1. Submit data on pipe materials, pipe fittings, valves, and accessories. Submit manufacturers' catalog information. Indicate valve data and ratings.
 - 2. Domestic Water Specialties: Submit manufacturer's catalog information, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit pump type, capacity, and power requirements.
 - 4. Submit certified pump curves showing pump performance characteristics with pump and system operating point plot. Include NPSH curve when applicable.
 - 5. Submit electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit installation instructions for pumps, valves, and accessories.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record install locations of valves and equipment.

- C. Operation and Maintenance Data: Submit product data, spare parts list, exploded assembly views, and recommended maintenance intervals.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Alaska codes and amendments.

1.06 QUALIFICATIONS

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 - Material and Equipment for product storage and handling requirements.
- B. Accept valves and equipment on-site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. See Division 01.
- B. Underground piping shall not be installed when bedding is wet or frozen.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 WATER PIPING, ABOVE GRADE INTERIOR:

- A. 2-1/2 inches and smaller.
 - 1. Copper Tubing: ASTM B88, Type L, hard drawn.
 - a. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - b. Joints: ASTM B32, solder, Grade 95TA. 95-5 tin-antimony or IAPMO approved lead free solder.
- B. Smoke and Fire Ratings:
 - 1. Field install wrap and/or insulate piping in plenums with fiberglass or mineral wool pipe insulation.
 - 2. The system is to have a flame spread classification of less than 25 and smoke development rating of less than 50.
 - 3. Pipe, wrap, or insulation as a system to meet the requirements of CAN/ULC-S102.2-03, ASTM E84, or UL 2846.

4. For insulation required for thermal and condensation reasons, see Section 22 07 00 - Plumbing Insulation.

2.02 STRAINERS

- A. Manufacturer: Watts, Apollo, or approved equal.
- B. For strainers less than 2 inches line size, provide strainers meeting NSF/ANSI 372: Wetted surfaces shall have a lead content less than 0.25 percent.
- C. 2 Inches and Larger: Threaded brass body for 400 PSI WOG; 125 psi WSP, Y pattern with No. 20 mesh, 304 stainless steel perforated screen.

2.03 FIRE STOP SYSTEMS

- A. See Section 07 84 00 - Firestopping.

2.04 WATER HAMMER ARRESTOR

- A. Manufacturers: Precision Plumbing Products, Sioux Chief, or approved equal.
- B. ASME A112.26.1, ASSE 1010, or PDI WH-201; stainless steel construction, piston type sized in accordance with PDI WH-201.
- C. Pre-charged suitable for operation in temperature range minus 100 to plus 300 deg F and maximum 250 psi working pressure.

2.05 DIAPHRAGM-TYPE COMPRESSION TANKS

- A. Manufacturers: Amtrol, Taco, or equal.
- B. Construction: Welded steel, tested and stamped in accordance with ASME Code, Section VIII, Division I; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible diaphragm sealed into tank, and steel legs or saddles.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; pre-charge to 40 psig.

2.06 DOMESTIC HOT WATER TEMPERING STATION (TV-1)

- A. Manufacturer: Guardian, Watts, or approved equal.
- B. Tempered hot water control system shall be factory assembled and tested and shall include two thermostatic mixing valves rack-mounted and shall be capable of maintaining water temperature to within 10 degrees of the set point within the range of 85 deg F to 120 deg F. Valves shall compensate for temperature fluctuations due to changes in inlet temperature and pressure. Valves shall be of bronze body with swivel action check stops with removable cartridge with strainer, stainless steel piston and liquid filled thermal motor with bellows element mounted out of water, inlet manifold piping, pressure reducing valve, two pressure gauges, two ball valves, bi-metal dial thermometer with three-inch face, wall mounting bracket, and connecting piping and shall insure precise control when tested in accordance with ASSE-1017 and CSA B125.
 1. Capacity: 20 gpm at 5 psi differential.
- C. Accessories:
 1. Check valve on inlets.

2. Volume control shut-off valve on outlet.
3. Thermometers on inlets and outlet.
4. Strainer stop checks on inlets.

2.07 LAVATORY TEMPERING VALVES

- A. Manufacturers:
 1. Basis of Design: Watts MMV-M1.
 2. Leonard Inc.
 3. Powers Inc.
 4. Or approved equal.
- B. Valve: Chrome plated cast brass body, stainless steel or copper alloy bellows, integral temperature adjustment. Conform to ASSE 1070 to temper hot water supply to the lavatories to maximum 110 deg F.
- C. Provide strainer stop checks on inlets.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify excavations are to required grade, dry, and not over-excavated.
- B. Verify components are clean and free of damage.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt, on inside and outside, before assembly.

3.03 INSTALLATION

- A. Install non-conducting dielectric connections wherever jointing dissimilar metals.
- B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- C. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00 - Plumbing Insulation.
- G. Provide 1-1/2 inches of insulation on cold water piping exposed in garage area between floor slab and mechanical room wall subject to freezing.
- H. Provide 1-1/2 inches of insulation on valves and fittings exposed in areas exposed to freezing.
- I. Provide access where valves and fittings are not exposed.

- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Provide support for utility meters in accordance with requirements of utility companies where applicable.
- L. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 23 - Interior Painting.
- M. Excavate and backfill in accordance with Section 31 20 00 - Earth Moving.
- N. Install valves with stems upright or horizontal, not inverted.
- O. Install water piping in accordance with ASME B31.9.
- P. Sleeve pipes passing through partitions, walls, and floors.
- Q. Install potable water protection devices on plumbing lines where contamination of domestic water may occur: on boiler feed water lines, premise isolation, flush valves, interior and exterior hose bibs.
- R. Pipe relief from valves, back-flow preventers and drains to nearest floor drain.
- S. Install water hammer arrester complete with accessible isolation valve on hot and cold water supply piping to shock producing fixtures, plumbing groups, and washing machine outlets. Water hammer arrester to be sized and installed per PDI Standards. Provide access doors where device is concealed.
- T. Use reducing fittings wherever a change in pipe size occurs. The use of bushings shall not be permitted.
- U. Slope domestic hot and cold piping to facilitate the complete drain-down of the piping system. Provide low-point drains with access doors.
- V. Provide insulation with vapor jacket on entire length of cold and hot water piping. Refer to Section 22 07 00 - Plumbing Insulation.

3.04 INTERFACE WITH OTHER PRODUCTS

- 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. Each branch pipe shall be controlled by a ball or gate valve where it connects to the main or riser. Each group of fixtures or isolated fixture shall be separately controlled by valves in accessible locations and provided with an access door where necessary.
- D. Install globe or ball valves for throttling, bypass, or manual flow control services.
- E. Provide lug end butterfly valves adjacent to equipment when functioning to isolate equipment.
- F. Provide spring loaded check valves on discharge of water pumps.
- G. Provide flow controls in water circulating systems where indicated.

3.05 ERECTION TOLERANCES

- A. See Division 01 for tolerances.

- B. Slope water piping minimum 0.25 percent and arrange to drain at low points.

3.06 CLEANING

- A. Disinfecting of Domestic Water:

1. Prior to starting work, verify system is complete, flushed, and clean.
2. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
3. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.
4. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.
5. Maintain disinfectant in system for 24 hours.
6. When final disinfectant residual tests less than 25 mg/L, repeat treatment.
7. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.
8. 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.

3.07 START-UP / DEMONSTRATION:

- A. See Section 22 00 00 - General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of the domestic water piping system. The demonstration shall include, but not be limited to, the following:
1. Proper support and vibration isolation of equipment and piping.
 2. Proper operation of valves and specialties.

END OF SECTION

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**SECTION 22 11 23
DOMESTIC WATER PUMPS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. In-line, seal-less centrifugal pumps.

1.02 ACTION SUBMITTALS

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

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.04 QUALITY ASSURANCE

- A. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

PART 2 - PRODUCTS

2.01 SYSTEM LUBRICATED CIRCULATORS (CP-3)

- A. Manufacturers: Grundfos or approved equal.
- B. Type: Horizontal shaft, single stage, direct connected with multiple speed wet rotor motor for in-line mounting, for 140 psig maximum working pressure, 230 deg F maximum water temperature.
- C. Casing: Stainless steel or cast-iron housing.
- D. Impeller: Non-metallic.
- E. Shaft: Ceramic.
- F. Seal: Carbon rotating against a stationary ceramic seat.
- G. Flexible drive coupling.
- H. NSF 372 certified.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install Work in accordance with State of Alaska standards and local code amendments.

- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- C. Provide line sized shut-off valve and line sized soft seat check valve and balancing valve on pump discharge.
- D. Install base mounted pumps on 3-1/2-inch concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00 - Cast-in-Place Concrete and Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- E. Provide air cock and drain connection on horizontal pump casings.
- F. Provide drains for bases and seals.
- G. Lubricate pumps before start-up.

3.02 FIELD QUALITY CONTROL

- A. See Sections 01 45 00 – Quality Control and 22 05 93 - Testing Plumbing Piping Systems.

3.03 START-UP / DEMONSTRATION

- A. See Section 22 00 00 - General Mechanical Provisions.
- B. Provide at least 4 hours of operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of pumps. The demonstration shall include, but shall not be limited to the following:
 - 1. Proper operation of system lubricated inline circulators.
 - 2. Proper operation of progressive capacity positive displacement pumps.
 - 3. Proper operation of base mounted, end-suction pumps.
 - 4. Proper operation of self-priming, end-suction pumps.

END OF SECTION

SECTION 22 13 00
FACILITY SANITARY SEWERAGE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes pipe, pipe fittings, connections, and equipment for sanitary sewer piping systems. This section also includes floor drains, cleanouts, trench drain sumps, sump pump, oil/water separator, and cleaned water transfer pumps.

1.02 REFERENCES

- A. ASME B16.3 (American Society of Mechanical Engineers) - Malleable Iron Threaded Fittings.
- B. ASME B16.4 (American Society of Mechanical Engineers) - Gray Iron Threaded Fittings.
- C. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.
- D. ASTM A47 - Standard Specification for Ferritic Malleable Iron Castings.
- E. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- F. ASTM A74 - Cast Iron Soil Pipe and Fittings.
- G. ASTM C564 - Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- H. CISPI 301 (Cast Iron Soil Pipe Institute) - Cast Iron Soil Pipe and Fittings for Hubless Cast Iron Sanitary Systems.
- I. CISPI 310 (Cast Iron Soil Pipe Institute) - Joints for Hubless Cast Iron Sanitary Systems.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 22 00 00 - General Mechanical Provisions.
- B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes for sewage-ejectors and manholes.
- C. Product Data:
 - 1. Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information. Indicate component sizes, rough-in requirements, service sizes, and finishes.
 - 2. Indicate pump type, capacity, power requirements, and certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Indicate electrical characteristics and connection requirements.
 - 3. Provide oil/water separator manufacturer's calculations that show that the oil water separator is in compliance with Alaska Department of Environmental Conservation (ADEC) effluent requirements when operating under detailed influent conditions. Calculations should show rise and impingement rate at specified specific gravities, water temperature, and oil droplet rise.
- D. Manufacturer's Installation Instructions: Submit installation instructions for material and equipment.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record install locations of equipment and clean-outs.
- C. Operation and Maintenance Data: Submit frequency of treatment required for oil/water separator. Include product data, spare parts lists, exploded assembly views for pumps and equipment.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with IAPMO 2009 UPC and local code amendments.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 22 05 00 - Basic Mechanical Materials and Methods: Product storage and handling requirements.
- B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Underground piping shall not be installed when bedding is wet or frozen.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Polyvinyl Chloride (PVC) Pipe:
 - 1. PVC Piping: Schedule 40; conforming to ASTM D2729.
 - 2. Fittings: Injection mold conforming to ASTM D2665, or fabricated conforming to ASTM F1866.
 - 3. Seal material: Neoprene or Viton. EPDM shall not be used for oily service.
 - 4. PVC primer and glue shall be UPC listed, apply in accordance with manufacturer instructions.
- B. Provide piping compatible with hydraulic oil at system temperature and pressure.

2.02 SANITARY SEWER WASTE AND VENT AND OIL VENT PIPING

- A. Polyvinyl Chloride (PVC) Pipe:
 - 1. PVC Pipe: Schedule 40; conforming to ASTM D2729.

2. Fittings: Injection mold conforming to ASTM D2665, or fabricated conforming to ASTM F1866.
 3. Seal Material: Neoprene or Viton. EPDM shall not be used for oily service.
 4. PVC primer and glue shall be UPC listed, apply in accordance with manufacturer instructions.
- B. Provide piping compatible with hydraulic oil at system temperature and pressure;

2.03 PUMPED WASTE PIPING

- A. Polyvinyl Chloride (PVC) Pipe:
1. PVC Pipe: Schedule 40; conforming to ASTM D2729 where piping is concealed.
 2. PVC Pipe: Schedule 80; conforming to ASTM D2729 where piping is exposed.
 3. Fittings: Injection mold conforming to ASTM D2665, or fabricated conforming to ASTM F1866.
 4. Seal Material: Neoprene or Viton. EPDM shall not be used for oily service.
 5. PVC primer and glue shall be UPC listed, apply in accordance with manufacturer instructions.
 6. Provide smoke and fire rated PVC piping where piping is in a plenum space. The system shall have a flame spread classification of less than 25 and smoke development rating of less than 50.
- B. Provide piping compatible with hydraulic oil at system temperature and pressure.

2.04 FIRE STOP SYSTEMS

- A. Reference Section 07 84 00 - Firestopping.

2.05 OIL/WATER SEPARATOR (OWS-1)

- A. Oil/water separator manufacturers: Highland Tank, Anchorage Tank, or approved equal.
- B. Provide a shop fabricated oil water separator system which is comprised of a 7-foot-long, 2-foot-wide, 3-foot-tall tank with removable lid containing an inlet compartment with velocity diffusion baffle and sludge and sediment basin, separator compartment with removable sinusoidal, oil coalescing plates and integral waste oil storage, a removable polypropylene "Petro-Screen" impingement coalescer, an outlet compartment, and level sensors and alarms.
- C. Oil/water separator shall be designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil/water mixtures, sized as shown on the Drawings.
- D. Waste oil storage shall be contained in the upper 30 percent of the separator compartment, which shall be capable of emergency oil spill capacity equal to 60 percent of the total vessel volume. Effluent shall contain no more than 10 ppm suspended oil and grease and shall remove oil and grease droplets equal to and greater than 20 microns.
- E. Construction:
1. Material: Single wall fabricated steel welded construction.
 2. Rough-in: Above floor installation. Oil/water separator to be accessible on sides for repair work.
- F. Accessories: Integral oil storage tank, coalescing compartment with coalescing plates, vent for each separator compartment, corrosion control, lifting lugs, automatic high oil level and low water level alarms, and oil pump-out port with containment. Level sensors and alarms to be intrinsically safe. Provide a single point electrical connection with NEMA IV enclosure. Provide auxiliary alarm and status contacts for building HVAC DDC interface. See Section 23 09 93 - Sequence of Operation for Controls.

- G. Cover: Air-tight, gasketed access panels allowing complete accessibility to compartments.

2.06 SUMP PUMP (SP-1 AND 2)

- A. Manufacturers: Moyno, Liberty Pump, or approved equal.
- B. Type: Progressing cavity positive displacement, self-priming, and max working temperature and pressure of 140 deg F and 20 psig, low shear stator.
- C. Construction: Hermetically sealed motor windings embedded in polyurethane sealed in stainless steel housing. Perforated heavy galvanized steel strainer. Stainless steel shaft.
- D. Controls: Provide corrosion resistant float switches for high sump level alarm, pump on and pump off, and manual, wall mounted pump on override switch. Terminals for electrical components that could be located within a hazardous environment shall be intrinsically safe.
- E. Accessories: Oil-resistant 10-foot cord and plug with three-prong connector for electrical outlet. Level sensors to be Anchor Scientific Roto-float-SST switches.
- F. Provide fiberglass sump of size and depth indicated on contract drawings. Provide steel cover plate with inspection opening, discharge and vent piping fittings, and cover, and alarm fittings. Provide fittings for two pump discharge piping, vent piping, pump power cables, and level sensor cables. Sump lid shall be 1/4 inch thick primed and painted steel, bolted and gasketed airtight to mounting frame.
- G. Basis of design Liberty Pump EV280 Series part of ELV280 package.
- H. finished floor.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. See Section 01 31 14 - Work Coordination: Coordination and project conditions.
- B. Verify excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Pitch underground cast iron pipe within the building a minimum of 1/4 inch per foot in the direction of flow (install trench drain piping at 1/8 inch per foot after going under structural tension ties). Make changes in direction of drainage lines with 45-degree wyes, long turn wyes, or sweep bends. Use long-turn fittings wherever space conditions permit. Provide waterproofing around lines penetrating through foundation walls and floor slabs.
- B. Check and verify inverts of lines within and outside the building.

- C. Install traps on fixtures and equipment requiring connection to the sanitary system. Traps shall be of same size as the pipe on which they occur. Provide cleanouts for traps. Vent traps as shown and as required by local codes.
- D. Cleanouts: Provide at the base of each stack, each change in direction, and on a minimum of 50-foot centers at horizontal runs. Cleaning screws, deck plates, and other plugs shall be made up with graphite and oil only; use no grease or cement.
- E. Pitch vent lines to allow for condensation drainage.
- F. Group piping whenever practical at common elevations.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
- H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00 - Plumbing Insulation.
- I. Provide access where valves and fittings are not exposed.
- J. Install piping penetrating roofed areas to maintain integrity of roof assembly.
- K. Encapsulate exposed p-traps, angle stops and supply piping, located under handicap accessible lavatories, and sinks with fire resistant, molded foam insulation, to protect against scalding and scraping.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 91 23 – Interior Painting.
- N. Excavate and backfill in accordance with Section 31 20 00 - Earth Moving.
- O. Install bell and spigot pipe with bell end upstream.
- P. Sleeve pipes passing through partitions, walls, and floors.

3.04 START-UP / DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of the sanitary waste and vent system. The demonstration shall include, but not be limited to the following:
 - 1. Proper support and vibration isolation of equipment and piping.
 - 2. Proper operation of valves and specialties.
 - 3. Proper operation of the oil water separator and sump pump.

END OF SECTION

**SECTION 22 15 14
SHOP COMPRESSED AIR**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes pipe and pipe fittings, reciprocating air compressor, air receiver and accessories, air cooled air dryer, pressure-reducing station, hose reels, and accessories.

1.02 REFERENCES

- A. ASME B16.3 (American Society of Mechanical Engineers) - Malleable Iron Threaded Fittings.
- B. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.
- C. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- D. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- E. MSS SP-110 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.03 SUBMITTALS

- A. Submit under the provisions of Division 01 and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit manufacturer's catalog literature with capacity, weight, and electrical characteristics and connection requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Division 01 and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of equipment piping, valves, outlets, and components.
- C. Operation and Maintenance Data: Submit product data, assembly views, maintenance and lubrication instructions, replacement part numbers and availability.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME SEC IX for welding materials and procedures.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

- C. Testing Laboratory: Company specializing in performing Work of this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01.
- B. Accept equipment on-site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.
- C. Protect piping and equipment from weather and construction traffic. Maintain factory packaging and caps in place until installation.

PART 2 - PRODUCTS

2.01 COMPRESSED AIR PIPE AND PIPE FITTINGS

- A. Steel Pipe: ASTM A53, Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234, forged steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.9.

2.02 COMPRESSED AIR VALVES

- A. Manufacturers: Nibco, Milwaukee, or approved equal.
- B. Ball Valves: MSS SP-110, 600 psi, two-piece cast bronze body, TFE seats, standard port, anti-blowout stems, chrome-plated carbon brass/bronze ball, full depth ANSI thread ends.
- C. Air Outlets: Valves shall vent air to atmosphere upon closure.

2.03 PRIMARY FILTER AND REGULATOR

- A. Manufacturer: ARO model P29241-814, Speedaire 4ZK79, or approved equal.
- B. Filter regulator combination unit gauge rated for 250 psi with an adjustable range of 10 to 175 psi, gauge, and 40-micron filter element with automatic drain with manual override. Zinc die-cast body, zinc die-cast bowl, sight glass, 1-inch FPT and clip bracket mounting rated for minimum 140 cfm flow rate.

2.04 OUTLET FILTERS AND REGULATORS

- A. Manufacturer: ARO model P39344-614, Parker P33E, or approved equal.
- B. Filter regulator combination unit gauge rated for 250 psi with an adjustable range of 5 to 125 psi, gauge, and 5-micron filter element with semi-automatic drain with manual override. Zinc die-cast body, zinc die-cast bowl, sight glass, 1/2-inch FPT and clip bracket mounting rated for minimum 94 cfm flow rate.

2.05 AIR COMPRESSOR (AC-1)

- A. Manufacturers: Champion, Ingersoll Rand, or equal.
- B. Compressor: Oil-flooded, rotary-screw type with lubricated helical screws and lubricated gear box.
 - 1. Coupling: Nonlubricated, flexible type.

2. Cooling/Lubrication System: Unit-mounted, air-cooled exchanger package prepiped to unit; with air pressure circulation system with coolant stop valve, full-flow coolant filter, and thermal bypass valve.
 3. Air Filter: Dry type, with maintenance indicator and cleanable, replaceable filter element.
 4. Air/Coolant Receiver and Separation System: 150 psig rated steel tank with ASME safety valve, coolant-level gauge, multistage air-coolant separator element, minimum pressure valve, blowdown valve, discharge check valve, coolant stop valve, full-flow coolant filter, and thermal bypass valve.
 5. Capacity Control: Capacity modulation between zero and 100 percent air delivery, with operating pressures between 50 and 100 psig. Include necessary control to hold constant pressure. When air demand is zero, unload compressor by using pressure switch and blowdown valve.
 6. Tank Drain: Provide optional automatic pneumatic tank drain.
 7. Motor: Constant speed 1,800 rpm with electronic overheating protection in each phase with full voltage starting.
 8. Controls:
 - a. Control Panel: Factory wired, steel, with power and control wiring, factory wired for single point power connection.
 - b. Starter: Magnetic starter with manual reset current overload protection, starter relay, control power transformer, terminal strip for connection to interface equipment.
 - c. Safety Controls: Low oil level monitor.
 - d. Panel Face: Compressor run light, start-stop switch.
- C. Wiring Terminations: Furnish terminal lugs to match branch-circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box.
- D. Provide disconnect switch on wall adjacent to unit with conduit connection to compressors power connection.

2.06 AIR RECEIVER

- A. Manufacturers: Champion, Ingersoll Rand, or equal.
- B. Receiver: Orientation as indicated in schedule, built to ASME regulations for working pressure of 200 psi with ASME stamp. Flange or screw inlet and outlet connections. Integral to compressor assembly.
- C. Fittings: Adjustable pressure regulator, safety valve, pressure gauge, and non-electric automatic float actuated drain valve with in-line cleanable strainer and no stand-by air loss.
- D. Tank Finish: Factory Standard Finish.

2.07 COMPRESSED-AIR DRYERS - REFRIGERANT TYPE

- A. Manufacturers: Champion, Ingersoll Rand, or equal.
- B. Description: Noncycling, air-cooled, electric-motor-driven unit with steel enclosure and capability to deliver 35 deg F, 100 psig air at dew point. Include automatic ejection of condensate from airstream, step-down transformers, disconnect switches, inlet and outlet pressure gauges, thermometers, automatic controls, and filters.

2.08 COMPRESSED AIR HOSE REELS (HR-1)

- A. Manufacturer: Graco XD-30, Alemite Corporation 8078-M, or approved equal.

- B. Hose reels to be heavy duty, corrosion resistant, single post construction, spring-powered and self-retracting with latches on two sections per revolution of the sheave, with latch released from the ratchet with a pull on the hose to initiate hose retraction. Spring cassette and bearings shall be sealed. Hose reels to be wall or ceiling mountable with heavy duty mounting plate. Provide reels size to handle 1/2-inch I.D. hoses up to 75 feet in length with a burst pressure of 300 psi. Provide hose spring rewind reels with roll formed channel frame for heavy-duty installation. Reel shall have swivel joint inlets and outlet risers to handle required lengths of hose. Provide with a 4-way roller assembly, hose stops and baked enamel factory finish.
- C. Rewind: Provide with heavy-duty spring motor for self-contained rewinds. A non-sparking ratchet assembly locks the reel when the desired length of hose has been played out. A pull on the hose unlocks the reel and the spring motor retracts the hose. A declutching arbor is provided to prevent damage from reverse winding.
- D. Inlets: Standard inlets are 90-degree balanced pressure swivel joints with 1/2-inch female NPT threads. Outlets: Standard outlets are 1/2-inch female NPT threads.
- E. Operating Pressures and Temperatures:
 - 1. 200 psi.
 - 2. 20 deg F to 225 deg F.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Pre-Installation Cleaning: Disassemble positive pressure air systems pipe, fittings, valves, and components, except those supplied cleaned and inspect for contamination of dirt, or grit. Blow out dirt and grit with compressed air ensuring interior of pipe is clean, cap ends until installation.

3.02 INSTALLATION

- A. Install compressor unit on concrete housekeeping pad.
- B. Install compressor unit on vibration isolators. Level and bolt in place.
- C. Make air valve and drain connection on horizontal casing.
- D. Install line size gate valve on compressor discharge.
- E. Route condensate drains to nearest floor drain.
- F. Install bypass with valves around air dryer.
- G. Insulate hot inlet piping. Refer to Section 23 07 00 - HVAC Insulation.
- H. Install drip connections with valves at low points of piping system.
- I. Install take-off to outlets from top of main, with shut-off valve after take-off. Slope take-off piping to outlets.
- J. Install tees instead of elbows at changes in direction of piping. Fit open end of each tee with plug.
- K. Identify piping system and components.

- L. Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with pipe fittings.
- M. Cut pipe accurately and install without springing or forcing.
- N. Grade piping down in direction of flow.
- O. Install pipe sleeves where pipes pass through walls, floors, roofs, and partitions. Finish flush at both ends. Extend 2 inches above finished floors. Pack space between pipe or tubing and sleeve, and caulk.
- P. Identify piping with tape and decals. Provide piping identification code and schematic. Install labeling on pipe at intervals of not more than 20 feet and at least once in each room and each story traversed by pipeline.
- Q. Except where indicated, install manual shut-off valves with stem vertical and accessible for operation and maintenance.
- R. Install strainers on inlet side of pressure reducing valves. Provide main air valves (pressure reducing or flow control) with bypasses and isolation valves to allow maintenance without interruption of air.

3.03 FIELD QUALITY CONTROL

- A. Compressed Air Piping Leak Test: Prior to initial operation, clean and test compressed air piping in accordance with ASME B31.9.
- B. Check each station outlet of every piping system to determine test air is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adapter. Do not use universal adapter.

3.04 START-UP / DEMONSTRATION

- A. As specified in Section 22 00 00 - General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT's Representative the complete and proper operation of the shop air delivery system. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation of the shop air compressor.
 - 2. Proper support and vibration isolation of equipment and piping.
 - 3. Proper operation of valves and specialties.

END OF SECTION

**SECTION 22 34 00
DOMESTIC WATER HEATERS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes domestic water heaters.

1.02 SUBMITTALS

- A. Submit under the provisions of Section 22 00 00 - General Mechanical Provisions.
- B. Shop Drawings: Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.
- C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity, and power requirements. Submit certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Submit electrical characteristics and connection locations.
- D. Manufacturer's Installation Instructions: Submit mounting and support requirements.

1.03 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 – General Mechanical Provisions.
- B. Operation and Maintenance Data: Submit product data, installation instructions, replacement part numbers and availability.

1.04 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

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

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 INDIRECT-FIRED DOMESTIC WATER HEATER (WH-1)

- A. Manufacturer: Weil McClain, US Boiler Company, or approved equal.
- B. Type: AHRI certified, Indirect fired hot water generator with double walled emersion coil, vertical storage tank and boiler water circulator.
- C. Tank: Deep-drawn welded steel outer shell with enamel finish, working pressure of 150 psig, integral steel support stand, taps for accessories, threaded connections, access hand hole, closed aquastat well. Seamless inner lining of polyethylene.
- D. Tubes: double walled, emersion coil type with 3/4-inch diameter seamless copper tubes suitable for 150 psi working pressure. Removable for inspection and cleaning, with black iron pipe for boiler supply and return connections.
- E. Unit shall carry a minimum one-year warranty and be rated for 150 psi design tank pressure.
- F. Accessories: Tank drain, water outlet, thermometer range of 40 to 200 deg F, ASME pressure relief valve suitable for maximum working pressure. ASME rated pressure and temperature relief valve on heated water discharge. Provide thermometers and pressure gauge taps on water outlets.
- G. Controls: Electronic control with built-in diagnostics with dry contact, and adjustable temperature differential settings.
- H. Insulation: Factory-furnished 2-inch molded rigid insulation between inner polyethylene liner and outer shell.

2.02 POINT OF USE WATER HEATER (WH-2)

- A. Manufacturer: Rheem, Bock, or equal.
- B. Type: AHRI certified, Factory-assembled and wired, electric, vertical storage.
- C. Maximum working pressure: 150 psig.
- D. Tank: Glass lined welded steel; thermally insulated with minimum 2 inches polyurethane encased in corrosion-resistant steel jacket; baked-on enamel finish.
- E. Controls: Automatic water thermostat; externally adjustable temperature range from 60 to 180 degrees F, flanged or screw-in elements, high temperature limit thermostat.
- F. Accessories: Brass water connections and dip tube, drain valve, magnesium anode, and ASME rated temperature and pressure relief valve.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate with plumbing piping and electrical work to achieve operating system.
- B. Maintain manufacturer's recommended clearances around and over water heaters.

- C. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00 – Cast-in-Place Concrete.
- D. Install the following piping accessories.
 - 1. On Supply:
 - a. Thermometer well and thermometer.
 - b. Union.
 - c. Automatic vacuum relief valve.
 - d. Temperature and pressure relief valve.
 - e. Shutoff valve.
 - 2. On Return:
 - a. Thermometer well and thermometer.
 - b. Check valve.
 - c. Shutoff valve.
 - d. Union.
- E. Install discharge piping from relief valves and drain valves to nearest floor drain.
- F. Install circulator and diaphragm expansion tank on water heater.
- G. Install water heater trim and accessories furnished loose for field mounting.
- H. Install electrical devices furnished loose for field mounting.
- I. Install control wiring between water heater control panel and field mounted control devices.

3.02 FIELD QUALITY CONTROL

- A. Arrange with local authorities having jurisdiction for inspection of water heater, piping, and for certificate of operation.

3.03 START-UP / DEMONSTRATION

- A. As specified in Section 22 00 00 - General Mechanical Provisions.
- B. Provide at least one hour of operating and maintenance instructions for maintenance personnel responsible for operating the boiler equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT's Representative the complete and proper operation of systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation and installation of water heaters, controls, safety devices and associated appurtenances.
 - 2. Manufacturer's recommended maintenance access and clearances have been maintained.

END OF SECTION

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**SECTION 22 40 00
PLUMBING FIXTURES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes water closets, lavatories, showers, sinks, service sinks, shop sink, drinking fountain, and emergency eye wash.

1.02 REFERENCES

- A. ANSI Z124.1.2 – Plastic Bathtub and Shower Units.
- B. ANSI Z358.1 – Emergency Eye Wash and Shower Equipment.
- C. ASME A112.18.1 (American Society of Mechanical Engineers) – Finished and Rough Brass Plumbing Fixture Fittings.
- D. ASME A112.19.2 (American Society of Mechanical Engineers) – Vitreous China Plumbing Fixtures.
- E. ASME A112.19.3 (American Society of Mechanical Engineers) – Stainless Steel Plumbing Fixtures (Designed for Residential Use).
- F. ASSE 1011 (American Society of Sanitary Engineering) – Hose Connection Vacuum Breakers.
- G. ASSE 1019 (American Society of Sanitary Engineering) – Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

1.03 SUBMITTALS

- A. Submit under the provisions of Sections 01 33 00 – Submittal Procedures and 22 00 00 – General Mechanical Provisions.
- B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 73 00 – Execution Requirements and Section 22 00 00 – General Mechanical Provisions.
- B. Operation and Maintenance Data: Submit fixture product data, installation instructions, trim, exploded view and replacement parts lists.

1.05 QUALITY ASSURANCE

- A. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., as suitable for purpose specified and indicated.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Material and Equipment.
- B. Accept fixtures on site in factory packaging. Inspect for damage.
- C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

PART 2 - PRODUCTS

2.01 WATER CLOSET (WC-1)

- A. Manufacturers: Mansfield, Kohler, or approved equal.
- B. Bowl: ASME A112.19.2; wall mounted, vitreous china closet bowl, with elongated rim, provide with wall hanger.
- C. Seat: Solid white plastic, open front, extended back, self-sustaining external check hinge, stainless steels bolts. Bemis 1955 seat.

2.02 LAVATORY (LAV-1)

- A. Manufacturers: Mansfield, Kohler, or approved equal.
- B. Self-rimming lavatory: ASME A112.19.2; ADA approved, 19-1/2-inch by 16-3/4-inch, vitreous china with wall hanger and 4-inch faucet centers, front overflow.

2.03 LAVATORY FAUCET

- A. Manufacturer: Chicago Faucet, American Standard, or approved equal.
- B. Manual Lavatory Faucet: ASME A112.18.1; single lever handle faucet with hot and cold color indicators. Provide open grid strainer. Provide ASSE-1070 hot water tempering valve on hot water supplies at lavatories.

2.04 LAUNDRY SINK (LS-1)

- A. Manufacturer: Just Manufacturing, Elkay, or approved equal.
- B. Floor mounted 14-gauge stainless steel laundry tub/ service sink with seamless welded construction, all interior exposed surfaces polished to hand-blended finish, brushed finish on exterior exposed surfaces. Provide with Just model J-35-FS drain.

2.05 LAUNDRY SINK FAUCET

- A. Manufacturer: Chicago Faucets, T&S, or approved equal.
- B. Manual Service Sink Faucet: ASME A112.18.1; service sink faucet with chrome plated brass construction, spout, hose end connection, integral vacuum breaker, wall support bracket, bucket hook, 2-3/8 inch 1/4-turn handles.

2.06 SHOWER SURROUND (SH-1)

- A. Manufacturers: Accessibility Professionals, Aquatic, or approved equal.
- B. Cabinet: Cast acrylic one piece, integral front trench drain, grab bars, and soap dish.

2.07 SHOWER FAUCET

- A. Manufacturers: Chicago Faucet, Symmons, or approved equal.
- B. Shower Valve: ASME A112.18.1; ASSE 1016 pressure balancing valve with integral series stops and checks to prevent cross flow.
- C. Provide with diverting valve, 1.5 gpm wall mounted shower head, 36-inch ADA grab bar with 1.5 gpm hand spray with pause control.

2.08 OFFICE SINK (KS-1)

- A. Manufacturers: Just Manufacturing, Elkay, or approved equal.
- B. Single Compartment Bowl: ASME A112.19.3; ADA compliant, countertop, type 304, 18 gauge stainless steel sink with 6-1/2-inch deep compartments, 16 inches by 16 inches, and 22 inches by 37 inches overall. Provide single hole punchings for faucet, drain basket strainer, Just Manufacturing model #J-35, Elkay LKAD35, or approved equal.

2.09 OFFICE SINK FAUCET

- A. Manufacturer: Chicago Faucet, Elkay, or approved equal.
- B. Manual Sink Faucet: ASME A112.18.1; Single lever handle faucet, ceramic volume control, single hole deck mounted faucet, and 10-inch spout with aerator. Provide ASSE-1070 hot water tempering valve on hot water supplies.

2.10 CLOTHES WASHER WALL BOX (P-7)

- A. Manufacturers: Precision Plumbing Products, Guy Grey, or approved equal.
- B. Recessed, white powder coated steel wall mounted wall box, 7-11/16 inches wide by 6 inches high by 3-1/2 inches maximum deep, hot and cold 1/2-inch inlet, 3/4-inch hose thread outlet valve, integral water hammer arrestor, and 2-inch drain.

2.11 WATER CLOSET FLUSH VALVE

- A. Manufacturers: Sloan, Moen Commercial, or approved equal.
- B. Exposed Flush Valve: ASME A112.19.2; exposed chrome plated brass, lever operated diaphragm flushing type, non-hold-open handle, chrome plated escutcheon, integral screwdriver stop and vacuum breaker; maximum 1.28 gallon flush volume.

2.12 EMERGENCY EYEWASH (EW-1)

- A. Manufacturers: Guardian, Acorn, or approved equal.

- B. ANSI Z358.1; wall-mounted, 11-1/8-inch stainless steel bowl, instant action stay-open valve actuated by push flag, twin spray heads with flip-top dust covers, wall mount bracket, and 1-1/4-inch drain port. Furnish universal emergency sign. Provide tempered water supply from water tempering valve.

2.13 COMBINATION EMERGENCY SHOWER WITH EYEWASH (ES-1)

- A. Manufacturers: Guardian, Acorn, or approved equal.
 - 1. Source Limitations: Obtain combination units, emergency shower with eyewash, standard, plumbed, from single manufacturer.
 - 2. Piping:
 - a. Material: Galvanized steel.
 - b. Unit Supply: NPS 1-1/4 minimum.
 - c. Unit Drain: Outlet at back or side near bottom.
 - 3. Shower:
 - a. Capacity: Not less than 20 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Pull rod.
 - d. Shower Head: 8-inch- minimum diameter, plastic.
 - e. Mounting: Pedestal.
 - 4. Eyewash Unit:
 - a. Capacity: Not less than 13 gpm for at least 15 minutes.
 - b. Supply Piping: NPS 1/2 with flow regulator and stay-open control valve.
 - c. Control-Valve Actuator: Paddle.
 - d. Spray-Head Assembly: Two receptor-mounted spray heads.
 - e. Receptor: Chrome-plated brass or stainless steel bowl.
 - f. Mounting: Attached shower pedestal.

2.14 HOSE BIBB (HB-1)

- A. Manufacturers: Woodford, Jay R. Smith, or approved equal.
- B. Hose Bibb: ASSE 1011; Anti-contamination wall faucet for use in warm space. Single faucet with 3/4-inch supply, vacuum breaker, with hand wheel, and 3/4-inch hose thread spout. Bronze or brass with integral mounting flange, replaceable hexagonal disc.

2.15 FLOOR DRAIN (FD-1)

- A. Manufacturers: Jay R. Smith, Sioux Chief, or approved equal.
- B. Drain: Cast iron body, vandal proof nickel bronze strainer, Size 05 round strainer, and 1/2-inch trap primer connection.

2.16 FLOOR SINK (FS-1)

- A. Manufacturers: Jay R. Smith, Zurn, or approved equal.
 - 1. Standard: ASME A112.6.7.
 - 2. Pattern: Floor.
 - 3. Body Material: Cast iron.
 - 4. Anchor Flange: Required.
 - 5. Clamping Device: Not required.
 - 6. Outlet: Bottom, no-hub or caulk connection.
 - 7. Coating on Interior Surfaces: Not required.
 - 8. Sediment Bucket: Required.
 - 9. Internal Strainer: Flat.
 - 10. Internal Strainer Material: Aluminum.

11. Top Grate Material: Cast iron.
12. Top of Body and Grate Finish: Nickel bronze.
13. Top Shape: Square.
14. Dimensions of Top Grate: 8-1/2" square.
15. Top Loading Classification: No traffic.

2.17 FLOOR CLEANOUT (FCO)

A. Light Traffic Areas:

1. Manufacturers: Jay R. Smith, Sioux Chief, or approved equal.
2. Cast iron, Light duty top-loading classification, ASME A112.36.2M compliant, sized to match connected pipe diameter, circular cover shape, closure plug same size as or not more than one size smaller than cleanout size, and hubless.

B. Heavy Traffic Area:

1. Manufacturers: Jay R. Smith, Sioux Chief, or approved equal.
2. Cast Iron, heavy duty top-loading classification, ASME A112.36.2M compliant, sized to match connected pipe diameter, circular cover shape, closure plug same size as or not more than one size smaller than cleanout size, and hubless, ASTM A74 Extra-Heavy Service.

2.18 ELECTRIC TRAP PRIMER (ETP-1)

- A. Manufacturers: Mifab, Sioux Chief, or approved equal.
- B. Electronic trap priming manifold, solenoid valve, capable of serving one or more fixtures at least 15 feet from unit, working pressure of 100 psi and working temperature of 120 deg F, and in-wall housing with access door,
- C. Electric solenoid valve operated trap primer, ASSE 1044, UPC approved, operating on domestic water system, brass valve construction. Capable of operating range 35 to 75 psig.
- D. Provide isolation valve, union, and distribution piping to floor drains. Install valve minimum 12 inches above traps being primed.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

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

3.03 INSTALLATION

- A. Protect fixtures and equipment during construction. Replace if damaged.

- B. Provide chrome plated screwdriver operated angle stops, chrome plated supplies, p-traps and escutcheons on all piping connections to fixtures.
- C. Install each fixture with trap, easily removable for servicing and cleaning.
- D. Set fixtures level and square with relation to interior finish, floor, and wall lines. Install components level and plumb.
- E. Install and secure fixtures in place with wall carriers and bolts.
- F. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.
- G. Solidly attach water closets to floor with approved anchors. Lead flashing is not intended to hold fixture in place.
- H. Cover metal fixture trimmings with non-corrosive grease or approved protective tape and maintain until construction work is complete. Upon completion, remove protection and labels; clean and polish fixtures and trimmings.
- I. Mount hose bibs with spout 4 feet above finished floor.
- J. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
- K. Position plumbing fixtures for easy access and maintenance
- L. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- M. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

3.04 INTERFACE WITH OTHER PRODUCTS

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

3.05 ADJUSTING

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

3.06 CLEANING

- A. Clean plumbing fixtures and equipment.

3.07 PROTECTION OF INSTALLED CONSTRUCTION

- A. Do not permit use of fixtures before final acceptance.

- B. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

3.08 START-UP/DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Provide at least two hours of operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT, the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation of all plumbing fixtures and associated appurtenances.

END OF SECTION

SECTION 23 05 23
GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes valves for hydronic heating piping systems.

1.02 REFERENCES

- A. ANSI-Z21.22 (American National Standards Institute) - Relief Valves and Automatic Gas Shut off Devices for Hot Water Supply Systems.
- B. ASME B16.3 (American Society of Mechanical Engineers) - Malleable Iron Threaded Fittings.
- C. AWS (American Welding Society) - Welding and Brazing Qualifications.
- D. MSS SP-67 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Butterfly Valves.
- E. MSS SP 70 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Gate Valves, Flanged and Threaded Ends.
- F. MSS SP-71 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
- G. MSS SP-78 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Plug Valves, Flanged and Threaded Ends.
- H. MSS SP-80 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Bronze Gate, Globe, Angle and Check Valves.
- I. MSS SP-85 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Cast Iron Globe & Angle Valves, Flanged and Threaded Ends.
- J. MSS SP-110 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- K. Submit under the provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- L. Product Data: Submit manufacturer's catalog information with valve data and ratings for each service.
- M. Manufacturer's Installation Instructions: Submit hanging and support methods and joining procedures.

1.03 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of valves.

- C. Operation and Maintenance Data: Submit product data, installation instructions, spare parts lists, exploded assembly views.

1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with State of Alaska standards.

1.05 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 - Material and Equipment for product storage and handling requirements.
- B. Accept valves on-site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

PART 2 - PRODUCTS

2.01 ISOLATION VALVES

- A. Larger than 4 Inches: Gate valves.
 - 1. Manufacturers: Nibco, Milwaukee, or equal.
 - 2. Provide MSS SP-70, Class 125 WSP, 200 psi WOG, iron body, bronze trim, outside screw and yoke, hand-wheel, solid wedge disc, grooved or flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.
- B. 4 Inches and Smaller: Ball valves.
 - 1. Manufacturers: Nibco, Milwaukee, or equal.
 - 2. Provide MSS SP-110, Class 150 WSP, 400 psi WOG, bronze, two-piece body, chrome plated brass ball, full port ball, Teflon seats and stuffing box ring, blow-out proof stem, lever handle, connection: solder, threaded, grooved, or flanged ends.

2.02 GLOBE VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.
- B. Up to and Including 2 Inches: MSS SP-80, Class 150 WSP, 300 WOG, bronze body, bronze trim, union bonnet, hand-wheel, bronze or Teflon disc, connection: solder, threaded, grooved, or flanged ends.
- C. Larger than 2 Inches: MSS SP-85, Class 125 WSP, 200 WOG, iron body, bronze trim, hand-wheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, grooved, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.03 BALANCING VALVES

- A. Manufacturer: Armstrong CBV Balance Valves, Bell & Gossett Circuit Setter Plus Calibrated Balance Valves, or equal.
- B. Provide calibrated positive shut-off balancing valves with tamper-proof memory stop that locks valve position, connections for a portable differential pressure meter and integral pointer to indicate valve setting.
- C. Meter connections shall be provided with built-in check valves; constructed with adequate seals and rated at 125 psi at 250 deg F.
- D. Each valve shall be furnished with a pre-formed, removable PVC insulation jacket.

2.04 CONTROL VALVES

- A. Furnish two-way, globe pattern control valves with equal percentage characteristics.
- B. Bronze body, bronze trim, rising stem, renewable composition disc, screwed, grooved, or flanged ends.
- C. Rated for a pressure of 125 psig at 250 deg F.
- D. Replaceable plugs and seats of stainless steel or brass.
- E. Size for 4 psig maximum pressure drop at design flow rate.

2.05 FLOW CONTROL VALVES

- A. Manufacturers: Griswold Controls, Bell & Gossett, or equal.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times pressure required for control; maximum valve pressure drop: 1.0 psi.
- D. Control Mechanism: Stainless steel or nickel-plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.06 SWING CHECK VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.
- B. Up to and Including 2 Inches: MSS SP-80, Class 150 WSP 300 WOG, bronze body, seat, and cap, bronze swing disc holder, composition disc, connection: solder, threaded, grooved, or flanged ends.
- C. Larger than 2 Inches: MSS SP-71, Class 125, cast iron body, bronze swing disc, renewable disc seal and seat, grooved or flanged ends.

2.07 SPRING LOADED CHECK VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.

- B. Construction: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.08 RELIEF VALVES

- A. Pressure Relief:
 - 1. Manufacturers: Nibco, Watts, or equal.
 - 2. Construction: ANSI Z21.22 certified, bronze body, Teflon seat, steel stem and springs, automatic, direct pressure actuated.
- B. Temperature and Pressure Relief:
 - 1. Manufacturers: Nibco, Milwaukee, or equal.
 - 2. Construction: ANSI Z21.22 certified, bronze body, Teflon seat, stainless steel stem and springs, automatic, direct-pressure-actuated, temperature relief maximum 210 deg F, capacity ASME SEC IV certified and labeled.

2.09 BUTTERFLY VALVES

- A. Manufacturers: Nibco, Milwaukee, or equal.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
- C. Disc: Aluminum bronze or chrome plated ductile iron.
- D. Operator: 10-position lever handle.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. See Division 01 for coordination and project conditions.
- B. Verify piping system is ready for installation.

3.02 INSTALLATION

- A. Provide non-conducting dielectric nipples or isolating flange connections wherever jointing dissimilar metals.
- B. Install valves with stems upright or horizontal, not inverted.
- C. Install butterfly, gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers. For shut-off and isolation valve sizes above 3 inches, use gate valves.
- D. Install globe valves for throttling, bypass, or manual flow control services.
- E. Provide spring loaded check valves on discharge of water pumps when flow is downward. Use swing check valves on horizontal and vertical flow direction.
- F. Provide flow controls in water re-circulating systems as indicated on Drawings.
- G. Use 3/4-inch gate or ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Conform to applicable piping specification for hangers and insulation.

END OF SECTION

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SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes pipe and equipment supports, hangers, anchors, bases, sleeves, and sealing of work to adjacent construction.

1.02 REFERENCES

- A. ASME B31.5 (American Society of Mechanical Engineers) - Refrigeration Piping.
- B. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.
- C. AWS D1.1 (American Welding Society) - Structural Welding Code - Steel.
- D. MSS SP58 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- E. MSS SP69 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP89 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. NFPA 13 (National Fire Protection Association) - Installation of Sprinkler Systems.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit manufacturers catalog data including load capacity.
- C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Manufacturer's Installation Instructions: Submit special procedures and assembly of components.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with International Building Code, International Mechanical Code and the Uniform Plumbing Code for piping support.
- B. Perform work in accordance with ASME B31.9 and AWS D1.1 for welding hanger and support attachments to building structure.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years experience.

- B. Installer: Company specializing in performing Work of this Section with minimum three years experience.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Manufacturers: Grinnell; B-Line Systems, Inc.; or approved substitute.
- B. Hydronic Piping:
 - 1. Conform to ASME B31.9, MSS SP58, MSS SP69, and MSS SP89.
 - 2. Hangers for Pipe Sizes 1/2- to 1-1/2 Inch: Malleable iron or carbon steel, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 6. Wall Support for Pipe Sizes to 3 Inches: Cast iron hooks.
 - 7. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 8. Vertical Support: Steel riser clamp.
 - 9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 10. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 11. Copper Pipe Support: Copper-plated, carbon steel ring.

2.02 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

2.03 INSERTS

- A. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.04 FLASHING

- A. Metal Flashing: 26 gauge thick galvanized steel.
- B. Metal Counterflashing: 22 gauge thick galvanized steel.
- C. Flexible Flashing: 47 mil thick sheet compatible with roofing.
- D. Caps: Steel, 22 gauge minimum; 16 gauge at fire-resistant elements.

2.05 EXPANSION JOINTS AND GUIDES

- A. Pipe Anchors: Shall be Keflex-Mave BA or equal copper for copper pipe.
- B. Pipe Guides: Shall be Keflex-Mave, Type BC or equal copper for copper pipe.

2.06 PIPING MAINS WITH EXPANSION LOOPS

- A. Expansion Loops: Shall be of the size and location shown on the Drawings.
- B. Pipe Guides: Shall be two-piece welded steel, bolted with sliding spider in cylinder type frame with four mounting holes, clearance for pipe insulation, minimum 2-1/2-inch travel. Metraflex, Keflex or equal.
- C. Pipe Guide Placement:
 - 1. U-Bends: Place the first guide on each side of the U-bend at a distance from the center of twice the height of the bend. Place each additional guide shown at equal spacing between the first guide and the anchor.
 - 2. Z-Bends: Place the first guide on each side of the Z-bend at a distance from the bend equal to the length of the offset. Place each additional guide shown at equal spacing between the first guide and the anchor.
 - 3. L-Bends: Guides shall be placed on the longest leg of the L-bend. Place the first guide at a distance from the bend of twice the length of the offset. Place each additional guide shown at equal spacing between the first guide and the anchor.
- D. Pipe Anchors: Shall be welded steel. Submit shop drawings.

2.07 SLEEVES

- A. Sleeves for Pipes through Non-fire Rated Floors: 18 gauge thick galvanized steel.
- B. Sleeves for Pipes through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gauge thick galvanized steel.
- C. Sleeves for Pipes through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel.
- F. Fire-stopping Insulation: Glass fiber type, non-combustible.
- G. Sealant: Acrylic.

PART 3 - EXECUTION

3.01 INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.02 PIPE HANGERS AND SUPPORTS

- A. Hangers and supports shall have a minimum safety factor of five based upon ultimate tensile strength or compressive strength, as applicable of the material used. Turnbuckles shall have the capacity of not less than the attached rod.
- B. Support horizontal piping as scheduled.
- C. Chain or strap hangers (plumber tape) will not be permitted.
- D. Install hangers with minimum 1/2-inch space between finished covering and adjacent work.
- E. Place hangers within 12 inches of each horizontal elbow.
- F. Use hangers with 1-1/2-inch minimum vertical adjustment.
- G. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- H. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- I. Provide bracing to prevent lateral movement.
- J. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- K. Do not support the weight of piping from mechanical equipment, pump flanges, coil connections, and related items.
- L. Support riser piping independently of connected horizontal piping.
- M. Provide insulated shields between all hangers or supports for insulated piping systems.
- N. Provide copper plated hangers and supports for copper piping and sheet lead packing between hanger or support and steel piping.
- O. Design hangers for pipe movement without disengagement of supported pipe.

3.03 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00 - Cast-in-Place Concrete.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- D. Provide rigid anchors for pipes after vibration isolation components are installed.

3.04 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. 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.

- C. Flash floor drains in floors with topping over finished areas with lead; 10 inches clear on sides with minimum 36- by 36-inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, shower, and mop sink drains watertight to adjacent materials.
- E. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- F. Provide curbs for mechanical roof installations 14 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach Counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- G. 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.

3.05 SLEEVES

- A. Set sleeves in position in forms. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.06 SCHEDULES

<u>Pipe Size</u>	<u>Maximum Hanger Spacing</u>	<u>Rod Diameter</u>
1/2-inch to 1-1/4 inch	6'-0"	3/8-inch
1-1/2-inch to 2-inch	10'-0"	3/8-inch
2-1/2-inch to 3 inch	10'-0"	1/2-inch
4-inch and over	10'-0"	5/8-inch
Cast-Iron (All Sizes)	5'-0"	1/2-inch

3.07 START-UP/DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper support of all piping systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper installation and support of all piping systems, including the installation of sleeves, seismic bracing, anchors and expansion joints.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes inertia bases and vibration isolation.

1.02 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping and ductwork.
- B. Provide minimum static deflection of isolators for equipment as follows:
 - 1. Under 400 rpm: 3.5-inch.
 - 2. 400 - 600 rpm: 3.5-inch.
 - 3. 600 - 800 rpm: 2-inch.
 - 4. 800 - 900 rpm: 1-inch.
 - 5. 1100 - 1500 rpm: 0.5-inch.
 - 6. Over 1500 rpm: 0.2-inch.
- C. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.
- D. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) as defined by ASHRAE Handbook.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit only items that are being used on the project. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- C. Design Data: Provide sealed engineering calculations of seismic restraints, bracing, and equipment anchor designs. Detailed calculations shall show the weight distribution for each equipment support and the loads at each vibration isolator.
- D. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers.
- E. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- F. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with AMCA 300 standards and recommendations of ASHRAE 68.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.07 SEISMIC CONTROL

- A. All other central equipment, machinery, tanks and all hereafter listed vibration isolation equipment shall be fitted with seismic restraint systems in accordance with FEMA 412 to resist seismic forces per SEI/ASCE 7-02. Refer to the General Structural Notes listed on the contract drawings for applicable seismic design data regarding spectral accelerations, site class, importance factor, and Seismic Use Group. Such items shall be as engineered, designed and manufactured by Mason Industries, Inc., Anaheim, CA or an equal. Stamped calculations and product data shall be submitted for evaluation and approval.
 - 1. Air Handling and Heat Recovery Units.
 - 2. Base Mounted Pumps.
 - 3. Boilers.
 - 4. Exhaust Fans.
 - 5. Unit Heaters.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 VIBRATION ISOLATORS

- A. Open Spring Isolators:
 - 1. Spring Isolators:
 - a. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25-inch-thick neoprene sound pads, and zinc chromate plated hardware.
 - 4. Sound Pads: Size for minimum deflection of 0.05-inch; meet requirements for neoprene pad isolators.
- B. Restrained Spring Isolators:
 - 1. Spring Isolators:
 - a. Code: Color code springs for load carrying capacity.
 - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.

3. Spring Mounts: Furnish with leveling devices, minimum 0.25-inch-thick neoprene sound pads, and zinc chromate plated hardware.
 4. Sound Pads: Size for minimum deflection of 0.05-inch; meet requirements for neoprene pad isolators.
 5. Restraint: Furnish mounting frame and limit stops.
- C. Closed Spring Isolators:
1. Spring Isolators:
 - a. Code: Color code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25-inch clearance.
- D. Restrained Closed Spring Isolators:
1. Spring Isolators:
 - a. Code: Color-code springs for load carrying capacity.
 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25-inch clearance and limit stops.
- E. Spring Hanger:
1. Spring Isolators:
 - a. Code: Color-code springs for load carrying capacity.
 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
 4. Misalignment: Capable of 20-degree hanger rod misalignment.
- F. Neoprene Pad Isolators:
1. Rubber or Neoprene-Waffle Pads:
 - a. Minimum 3/8-inch thick.
 - b. Maximum loading 60 psi.
 - c. Height of ribs: not to exceed 0.7 times width.
 2. Configuration: Single layer.
- G. Neoprene Mountings: Molded oil-resistant neoprene designed for 0.25-inch deflection with threaded insert.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. See Division 01: Coordination and project conditions.
- B. Verify equipment, ductwork and piping is installed before work in this section is started.

3.02 INSTALLATION

- A. Vibration isolator sizes shall be determined by the isolator manufacturer and shall be installed in accordance with the manufacturer's instructions.
- B. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- C. Install isolation for motor driven equipment.
 - 1. Bases:
 - a. Set steel bases for 1-inch clearance between housekeeping pad and base.
 - b. Adjust equipment level.
 - 2. Install spring hangers without binding.
- D. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- E. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers. Provide each inertia base with minimum of four seismic snubbers located close to isolators. Snub equipment designated for post disaster use to 0.05 inch maximum clearance. Provide other snubbers with clearance between 0.15 inch and 0.25 inch.
- F. Provide vibration hangers to support all piping and ductwork runs within the first 50 feet nearest the connection to rotating equipment and or isolated equipment.
 - 1. Select three hangers closest to vibration source for minimum 1.0-inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0-inch static deflection or 1/2 static deflection of isolated equipment.
- G. Connect wiring to isolated equipment with flexible hanging loop.
- H. Mechanical equipment shall be carefully checked upon delivery for proper mechanical performance which shall include proper noise and vibration operation.
- I. All installed rotating equipment with excessive noise and/or vibration which cannot be corrected in place shall be replaced at no cost to the DEPARTMENT.
- J. All vibrating equipment and the interconnecting pipe and ductwork shall be isolated to eliminate the transmission of objectionable noise and vibration from the structure.
- K. Mount or suspend all equipment and piping from approved foundations and supports, as shown.
- L. Erect all floor mounted equipment on minimum 4-inch high concrete pads over the complete floor area of the equipment, unless shown otherwise. Wherever vibration eliminating devices are specified, these

items shall be mounted on minimum 4-inch high concrete pads, unless shown otherwise. Pour concrete pads directly on or with the structural slab, except where inertia blocks are required and shown.

3.03 FIELD QUALITY CONTROL

- A. Inspect isolated equipment after installation and submit report. Include static deflections.
- B. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to mechanical equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.

3.04 SCHEDULES

EQUIPMENT ISOLATION SCHEDULE

ISOLATED EQUIPMENT	ISOLATOR TYPE
In-Line Pumps	Open spring hanger with seismic cable restraint
Floor-Mounted Pumps	Restrained open spring mount
Base-Mounted Utility and Cabinet Fans	Restrained open spring mount
Suspended Utility and Cabinet Fans	Open spring hanger with seismic cable restraint

3.05 START-UP/DEMONSTRATION

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation of all vibration isolation, and sound attenuation equipment.
- C. Seismic restraint and proper anchoring of all mechanical systems.

END OF SECTION

SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes nameplates, tags, and pipe markers.

1.02 REFERENCES

- A. ASME A13.1 (American Society of Mechanical Engineers) - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit manufacturers catalog literature for each product required.
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.

1.05 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.06 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 NAMEPLATES

- A. Manufacturers: Seton Identification Products, Brady, or approved substitute.
- B. Product Description: Bemis Lamicoid, Laminated three-layer plastic with engraved letters on light contrasting background color.

2.02 TAGS

- A. Plastic Tags:
 - 1. Manufacturers: Seton Identification Products, Brady, or equal.
 - 2. Bemis Lamicoid, Laminated three-layer plastic with engraved letters on light contrasting background color. Tag size minimum 1-1/2 inches diameter.
- B. Metal Tags:
 - 1. Manufacturers: Seton Identification Products, Brady, or equal.
 - 2. Brass with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- C. Information Tags:
 - 1. Manufacturers: Seton Identification Products, Brady, or equal.
 - 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- D. Tag Chart: Typewritten letter size list of applied tags and location in anodized aluminum frame.

2.03 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 - 1. Manufacturers: Seton Identification Products, Brady, or equal.
 - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers:
 - 1. Manufacturers: Seton Identification Products, Brady, or equal.
 - 2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

2.04 LABELS

- A. Manufacturers: Seton Identification Products, Brady, or equal.
- B. Description: Aluminum, size 1.9 by 0.75 inches, adhesive backed with printed identification.

PART 3 - EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

- A. General:
 - 1. Install identifying devices after completion of coverings and painting.
 - 2. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
 - 3. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
 - 4. Install tags using corrosion resistant chain. Number tags consecutively by location.

B. Piping:

1. Identify piping, concealed or exposed, with approved color-coded adhesive bands and indicate fluid type and flow direction. Directional arrows to be black not less than 1 inch long, on same background as symbols.
2. Identify piping at approximately 15-foot centers in all rooms, adjacent to each valve and tee, as well as in all the other spaces (such as shafts) in which piping may be viewed. There shall be at least one set of identifying bands per pipe in each space requiring identifying bands. In addition, the origination of each pipe main shall be further identified indicating the zone served.
3. Bands shall be applied where they can be easily read and with their long dimension parallel to the axis of the pipe.
4. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

C. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

D. Valves:

1. Identify valves in all areas with 1-1/2-inch by 3-inch Bemis Lamicoid identification tags installed on handwheels or stem with brass bead chain. Engrave identification tags indicating the service abbreviation and stating whether normally open (engraved on green) or normally closed (engraved on red).
2. Service abbreviation shall match pipe coding. In addition, each valve tag shall include a unique sequential identification number.

E. Equipment:

1. Provide manufacturer's nameplates on equipment, identifying manufacturer's name, model number, size, capacity, electrical characteristics, etc.
2. Leave manufacturer's nameplates clean and legible and visible. Install nameplates visible from normal path of equipment access.
3. Further identify all equipment with engraved Lamicoid identification tags secured to equipment. Identification shall conform to the equipment designation scheduled on the drawings. Securely fasten identification tags to equipment.
4. Equipment Includes:
 - a. Air Separator.
 - b. Boilers.
 - c. Cabinet Unit Heaters.
 - d. Day Tank.
 - e. Exhaust Fan.
 - f. Expansion Tanks.
 - g. Glycol Make-Up Tank.
 - h. Heat Recovery Ventilator.
 - i. Main Fuel Tank.
 - j. Make-Up Air Unit.
 - k. Pumps.
 - l. Radiant Floor Manifolds.
 - m. Unit Heaters.
 - n. Ventilation Fans.

F. Controls: Provide engraved Lamicoid identification tag of function on switches, controllers and manually operable or adjustable controls. Tag automatic controls, instruments, and relays. Key to control schematic.

- G. Identification Charts: Provide charts framed with glass or plastic front. Pipe identification chart shall list piping systems with symbol and color coding where applicable. Valve identification chart shall list valve model numbers and symbol for service corresponding to piping symbol. Mount identification charts in each mechanical area.
- H. VFD and Integral Controllers: Provide nameplates in accordance with Section 26 05 33 Identification for Electrical Systems.

3.03 SCHEDULES

PIPE IDENTIFICATION SCHEDULE

<u>Service</u>	<u>Abbreviation</u>	<u>Label Color</u>	
		<u>Background</u>	<u>Text</u>
Glycol Heating Supply	GHS	Green	White
Glycol Heating Return	GHR	Green	White

3.04 START-UP/DEMONSTRATION:

- A. See Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
 - 1. Adequate piping-finish painting and labels.
 - 2. Proper piping, valve, equipment tags and identifications charts are installed on all equipment and in each mechanical space.

END OF SECTION

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

PART 1 - GENERAL

1.01 SUMMARY

- A. The Work of this Section consists of testing apparatus and instruments and performing procedures to test, adjust, and balance the various air, fluid, mechanical, and electrical systems associated with the heating and ventilation systems.

1.02 REFERENCES

- A. AABC (Associated Air Balance Council) - National Standards for Total System Balance.
- B. ASHRAE 111 (American Society of Heating, Refrigerating and Air-Conditioning Engineers) - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- C. NEBB (National Environmental Balancing Bureau) - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.03 SYSTEMS INCLUDED

- A. Supply air system, including make-up air dampers.
- B. Exhaust air systems, including fans, ductwork, and appurtenances.
- C. Heating system, including pumps, terminal units, and appurtenances.
- D. Radiant slab, snowmelt, including pumps, heat exchangers, and manifolds.
- E. Automatic temperature controls and appurtenances.

1.04 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 - Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Test Reports: Indicate data on AABC National Standards for Total System Balance forms.
- C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- D. Balancing and Testing Plan: Submit, not less than three weeks before balancing and testing is scheduled to begin, a balancing and testing plan, which shall include the procedures, instructions, and reports to be used. Include all testing instruments and equipment certificates of calibration.
- E. Submit draft copies of report for review prior to final acceptance of Project. Furnish final copies for DEPARTMENT and for inclusion in operating and maintenance manuals.
- F. Furnish reports in three-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets and indicating thermostat locations.

1.05 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 77 00 - Contract Closeout Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of balancing valves and rough setting.
- C. Include final Testing and Balancing Report in the operations and maintenance manuals.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance.

1.07 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this Section with minimum three years documented experience.

1.08 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations. Make instruments available to DEPARTMENT's Representative to facilitate spot checks during testing.

3.03 INSTALLATION TOLERANCES

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

3.04 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by DEPARTMENT.
- F. Check and adjust systems approximately six months after final acceptance and submit report.

3.05 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in main ducts by pitot tube traverse of entire cross-sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- K. At modulating damper locations, take measurements and balance at extreme conditions.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.
- M. For variable air volume system powered units set volume controller to airflow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable-air-volume temperature control.
- N. On fan powered VAV boxes, adjust airflow switches for proper operation.

3.06 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain 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 system.
- C. Adjust systems to obtain 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 or in normal position 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, simulate full flow in one part by temporary restriction of flow to other parts.

3.07 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Fans.
 - 2. Air inlets and outlets.
 - 3. Unit heaters.
 - 4. Boilers
 - 5. Hydronic Pumps.
 - 6. Hydronic Flowsetters.
 - 7. Water heater.
- B. Report Forms:
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency.
 - b. Address of Testing, Adjusting, and Balancing Agency.
 - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency.
 - d. Project name.
 - e. Project location.
 - f. Project Architect.
 - g. Project Engineer.

- h. Project Contractor.
 - i. Project altitude.
 - j. Report date.
- 2. Summary Comments:
 - a. Design versus final performance.
 - b. Notable characteristics of system.
 - c. Description of systems operation sequence.
 - d. Summary of outdoor and exhaust flows to indicate building pressurization.
 - e. Nomenclature used throughout report.
 - f. Test conditions.
- 3. Instrument List:
 - a. Instrument.
 - b. Manufacturer.
 - c. Model number.
 - d. Serial number.
 - e. Range.
 - f. Calibration date.
- 4. Electric Motors:
 - a. Manufacturer.
 - b. Model/Frame.
 - c. HP/BHP and kW.
 - d. Phase, voltage, amperage; nameplate, actual, no load.
 - e. RPM.
 - f. Service factor.
 - g. Starter size, rating, heater elements.
 - h. Sheave Make/Size/Bore.
- 5. V-Belt Drive:
 - a. Identification/location.
 - b. Required driven RPM.
 - c. Driven sheave, diameter and RPM.
 - d. Belt, size and quantity.
 - e. Motor sheave diameter and RPM.
 - f. Center to center distance, maximum, minimum, and actual.
- 6. Combustion Test:
 - a. Manufacturer.
 - b. Model number.
 - c. Serial number.
 - d. Firing rate.
 - e. Overfire draft.
 - f. Fuel oil flow rate.
 - g. Heat input.
 - h. Burner manifold gas pressure.
 - i. Percent carbon monoxide (CO).
 - j. Percent carbon dioxide (CO₂).
 - k. Percent oxygen (O₂).
 - l. Percent excess air.
 - m. Flue gas temperature at outlet.
 - n. Ambient temperature.

- o. Net stack temperature.
 - p. Percent stack loss.
 - q. Percent combustion efficiency.
 - r. Heat output.
7. Return Air/Outside Air Data:
- a. Identification/location.
 - b. Design air flow.
 - c. Actual air flow.
 - d. Design return air flow.
 - e. Actual return air flow.
 - f. Design outside air flow.
 - g. Actual outside air flow.
 - h. Return air temperature.
 - i. Outside air temperature.
 - j. Required mixed air temperature.
 - k. Actual mixed air temperature.
 - l. Design outside/return air ratio.
 - m. Actual outside/return air ratio.
8. Exhaust Fan Data:
- a. Location.
 - b. Manufacturer.
 - c. Model number.
 - d. Serial number.
 - e. Air flow, specified and actual.
 - f. Total static pressure (total external), specified and actual.
 - g. Inlet pressure.
 - h. Discharge pressure.
 - i. Sheave Make/Size/Bore.
 - j. Number of Belts/Make/Size.
 - k. Fan RPM.
9. Terminal Unit Data:
- a. Manufacturer.
 - b. Type, constant, variable, single, dual duct.
 - c. Identification/number.
 - d. Location.
 - e. Model number.
 - f. Size.
 - g. Minimum static pressure.
 - h. Minimum design air flow.
 - i. Maximum design air flow.
 - j. Maximum actual air flow.
 - k. Inlet static pressure.
10. Air Distribution Test Sheet:
- a. Air terminal number.
 - b. Room number/location.
 - c. Terminal type.
 - d. Terminal size.
 - e. Area factor.
 - f. Design velocity.
 - g. Design air flow.

- h. Test (final) velocity.
- i. Test (final) air flow.
- j. Percent of design air flow.

END OF SECTION

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SECTION 23 05 95
TESTING BUILDING PIPING SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. The work of this section consists of testing building piping systems to ensure they are complete, operable, and ready for use.

1.02 QUALITY ASSURANCE

- A. Notify DEPARTMENT at least 96 hours before testing.
- B. Provide test equipment including test pumps, gauges, instruments, and other equipment required. Pressure gauges shall be graduated in increments not greater than 5 psi and shall have range of approximately twice test pressure. Use only gauges and instruments recently calibrated.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00 – Submittal Procedures.
- B. Submit system testing plans and final certifications that all systems pass the testing requirements specified hereinafter.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL

- A. Conduct tests in the presence of the DEPARTMENT, who shall be given 96 hours notice before any test is to be conducted. Provide water and electricity required for the tests. Determine that all dampers, registers, and valves are in a set or full open position.

3.02 PIPING

- A. Test before concealing piping. Before testing, isolate or remove all equipment from system that would be damaged by test pressure. Purge or bleed air from piping systems before performing hydrostatic testing. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system. Test time will be accrued only while full test pressure is on system. Replace removed equipment after testing.
- B. No loss of pressure will be allowed. Repair leaks found during tests by rewelding or replacing pipe or fittings. Caulking of joints will not be permitted. Makeshift remedies will not be permitted.
- C. Perform hydrostatic or pneumatic tests on piping in accordance with the following schedule. Maintain pressure for at least 24 hours. Perform tests in the presence of the DEPARTMENT. Unless otherwise specified below, tolerances for tests shall be no pressure drop, except that due to temperature change. Testing shall include all exterior fuel and secondary containment lines from tanks to the buildings.
 - 1. Glycol piping shall be tested both with water and a 30 percent propylene glycol mix, testing pressure shall be 150 psig.
 - 2. Diesel fuel piping shall be tested in accordance with NFPA 31.

3.03 PIPING SPECIALTIES

- A. Test thermometers, pressure gauges, and water meters for accurate indication.
- B. Verify proper operation of automatic water feeders, air vents, and vacuum breakers.
- C. Test air vent points to ensure all air has been vented.

3.04 VALVES

- A. Check valve bonnets for tightness and external leaks. Test manual and solenoid operated valves from closed-to-open-to-closed position while valve is under test pressure.
- B. Test automatic valves, including expansion, water regulating, pressure reducing, pressure relief, safety, and temperature and pressure relief valves at settings shown on the drawings or specified in the individual sections.
- C. Test pressure relief, safety, and temperature and pressure relief valves three times.

3.05 EQUIPMENT TESTS

- A. Upon completion of installation, but before applying power to any operating equipment or package control system, obtain the services of respective manufacturer's representative to inspect and witness trial runs of equipment. Inspection shall include alignment, direction of rotation, initial lubrication, RPM, voltage, amperage, and nameplate data.

3.06 HANGERS AND SUPPORTS

- A. With system in normal operation, test hangers, supports, and rods to ensure they are plumb and supporting proper share of load. Additionally support, as required, systems and equipment that sway, crawl, or vibrate.

3.07 EXPANSION TANKS

- A. Check proper water level when system is at working pressure and temperature.

3.08 OTHER MATERIALS AND EQUIPMENT

- A. Test other piping specialties, materials, and equipment as specified, as recommended by equipment manufacturer, or as directed.

3.09 CERTIFICATION

- A. CONTRACTOR shall submit a statement certifying that all tests were performed in accordance with the requirements of the Specifications and that no leaks and/or deficiencies were found or detected. The certification shall include the name of the company, date of testing, name and signature of the person performing the test, and verification by the DEPARTMENT.

END OF SECTION

**SECTION 23 07 00
HVAC INSULATION**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ductwork insulation.
 - 2. Duct liner.
 - 3. Insulation jackets.
 - 4. Equipment insulation.
 - 5. Piping system insulation.
 - 6. Insulation accessories including vapor retarders, jackets, and accessories.

1.02 REFERENCES

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus.
- C. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
- D. ASTM C449 - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
- E. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
- F. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- G. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation.
- H. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- I. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- J. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- K. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- L. NAIMA (North American Insulation Manufacturers Association) - National Insulation Standards.
- M. SMACNA (Sheet Metal and Air Conditioning Contractors National Association) - HVAC Duct Construction Standard Metal and Flexible.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit product description, thermal characteristics, and list of materials and thickness for each service, and location.

- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.

1.04 QUALITY ASSURANCE

- A. Composite insulation, including jackets, coverings, sealers, mastics, and wet or dry adhesives, shall have a flame-spread rating of 25 or less and smoke-developed rating of 50 or less, as tested by ASTM E84. Tubing insulation with a smoke-developed rating of 150 or less may be used on refrigeration lines. PVC fitting covers shall have a maximum flame spread of 25 or less and are excluded from the smoke spread criteria.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 – Material and Equipment for product storage and handling requirements.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 FIBROUS GLASS PIPE INSULATION

- A. Factory-molded fibrous glass with factory-applied all-service jackets, ASTM C547, Type I. Maximum thermal conductivity (k): 0.23 B-in/hr-ft²-°F at 75 deg F mean, Micro-Lok HP manufactured by Johns-Manville Corporation, Denver, Colorado; SSL II with ASJ Max manufactured by Owens Corning, Toledo, Ohio; or equal. Insulation exposed to the weather or physical damage shall be metal-jacketed, 650 ML.

2.02 CLOSED CELL RUBBER FOAM PIPE INSULATION

- A. Provide elastomeric foamed plastic closed-cell insulation in accordance with ASTM C534-89, Type I. Insulation shall be Armaflex II, manufactured by Armstrong World Industries, Inc., Lancaster, Pennsylvania; Insul-Tube manufactured by K-Flex USA, Youngsville, North Carolina; or equal. Thickness shall be 3/4 inch.

- B. Adhesive shall be the insulation manufacturer's recommended contact adhesive.
- C. Insulation finish shall be the insulation manufacturer's recommended finish.

2.03 PIPE FITTING AND VALVE COVERS

- A. One-piece compressed fibrous glass blanket and pre-molded PVC cover; thickness equal to adjoining pipe insulation. Provide PVC covers for all tees, 45-degree elbows, 90-degree elbows, and valve stems.
- B. All other fittings where PVC cover will not work shall be covered with spiral-wrapped glass mesh and finished with 1/16-inch-thick mastic coating.
- C. Provide layered closed cell insulation blankets on exterior water pipe grooved couplings and valves, thickness to match adjacent arctic pipe.

2.04 PIPE INSULATION ACCESSORIES

- A. Rigid Insulation Inserts for Pipe: Calcium silicate, or approved substitute, for installation between pipe and hanger. Provide cellular foam inserts for all cold piping systems. Insulation inserts shall be not less than 6 inches long for 1-1/2-inch to 2-1/2-inch pipe, and 9 inches long for 3-inch to 6-inch pipe; thickness equal to adjoining insulation.
- B. Rigid Insulation Inserts for Tube: J. M. Aerotube rigid insulation, as manufactured by Johns-Manville Corporation, Denver, Colorado; K-Flex 360 manufactured by K-Flex USA, Youngsville, North Carolina; or equal.
- C. Galvanized Metal Shields: 16 gauge for 3-inch and smaller pipe, and 14 gauge for 4-inch and larger; formed to fit the diameter of the insulation, extending up to the centerline of the pipe. Length equal to insulation hanger inserts.

2.05 PIPE INSULATION ADHESIVES, SEALANTS, AND VAPOR BARRIER MASTICS

- A. Foster, 3M, or equal. For tubing insulation, use products recommended by manufacturer.

2.06 PIPE INSULATION METAL JACKETS

- A. Aluminum Jacket: ASTM B209, 0.016-inch thick sheet thick with embossed finish, joint with longitudinal slip joints and 2-inch laps.
 - 1. Fittings: 0.016-inch-thick die shaped fitting covers with factory attached protective liner.
 - 2. Metal Jacket Bands: 3/8-inch-wide; 0.015-inch-thick aluminum.

2.07 RIGID FIBER GLASS DUCT BOARD:

- A. Rigid fiberglass ductwork insulation shall meet ASTM C 612 Type IA and IB.
 - 1. Manufacturers: Johns Manville, Schuller, Knauf, or equal.
 - 2. Maximum Thermal Conductivity (k): 0.24 B-in/hr-ft²-°F at 75 deg F mean.
 - 3. Maximum Service Temperature: 450 deg F.
 - 4. Vapor Retarded Jacket: All Service Jacket (ASJ) with a vapor barrier rated at 0.02 perms, conforming to ASTM C 1136 Type I, or Foil-Scrim-Kraft (FSK) conforming to ASTM C 1136 Type II.
 - 5. Securement: Secured in place using adhesive and mechanical fasteners spaced a minimum of 12 inches on center with a minimum of 2 rows per side of duct. Insulation shall be secured with speed washers and all joints, breaks and punctures sealed with appropriate pressure-sensitive foil tape, or glass fabric and vapor retarded mastic.

6. Finish: In finished areas, fan rooms and mechanical rooms, exposed ducts shall have 8-ounce canvas jacket adhered with Benjamin Foster 30-36. Size canvas with two heavy brush coats of same lagging adhesive.
7. Density: Minimum 6 PCF.

2.08 FLEXIBLE FIBERGLASS DUCT BLANKET

- A. Fiberglass flexible duct wrap shall meet ASTM C 553 Types I, II and III, and ASTM C 1290; flexible, limited combustible.
 1. Manufacturers: Johns Manville, Schuller, Knauf, or equal.
 2. Maximum Service Temperature:
 - a. Faced: 250 deg F.
 - b. Unfaced: 350 deg F.
 3. Maximum Thermal Conductivity (k): 0.29 B-in/hr-ft²-°F at 75 deg F mean.
 4. Vapor Retarded Jacket: Factory applied vapor barrier facing Foil-Scrim-Kraft (FSK) conforming to ASTM C 1136 Type II with a vapor barrier rated at 0.02 perms.
 5. Installation: Maximum allowable compression is 25 percent.
 6. Securement: Secured in place using outward cinching staples in combination with appropriate pressure-sensitive aluminum foil tape, or in combination with glass fabric and vapor retarded mastic.
 7. Density: Minimum 1.0 PCF.

2.09 CALCIUM SILICATE INSULATION

- A. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
- B. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
- C. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.10 METAL JACKET

- A. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
- B. Aluminum, Embossed: minimum 0.016 inch thick.
- C. Securement Bands:
 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing seal.

2.11 DUCT INSULATION FASTENERS

- A. Mechanical fasteners shall be in accordance with SMACNA Duct Liner Application Standard, 1975 edition.
- B. External: SMACNA MF-1-1975.

2.12 DUCT INSULATION ADHESIVE AND SEALER

- A. In accordance with SMACNA Duct Liner Application Standard, 1975 edition, and in compliance with Standard for Adhesive for Duct Liner, ASC-A-7001C-1972, Type I.

2.13 INSULATED FLEXIBLE DUCT

- A. UL 181, Class 1, Air Duct material complying with NFPA 90A and 90B.
- B. Factory fabricated assembly composed of a; black CPE Liner permanently bonded to a corrosion resistant helically wound spring steel wire; supporting a 1-inch-thick fiberglass insulation blanket; 0.10-perm fiberglass reinforced metalized film laminate vapor barrier with integral brass hanger grommets.
- C. Pressure Rating: 6-inch w.g. positive and 1-inch w.g. negative.
- D. Maximum Velocity: 4,000 FPM.
- E. Manufacturer: Thermaflex M-KE, Atco #037, or equal.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 INSTALLATION

- A. Exposed Piping: Locate insulation and cover seams in least visible locations.
- B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- C. Man-Made-Mineral-Fiber-Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
- D. For hot piping conveying fluids over 140 deg F, insulate flanges and unions at equipment.
- E. Man-Made-Mineral-Fiber-Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
 - 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.

- F. Inserts and Shields:
1. Application: Piping or Equipment 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 finish jacket.
 4. Insert configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
 5. Insert material: Compression resistant insulating material suitable for planned temperature range and service.
- G. 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 - Firestopping for penetrations of assemblies with fire resistance rating greater than 1 hour.
- H. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces. Finish with PVC jacket and fitting covers or aluminum jacket.
- I. Exterior Applications: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with 316 stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal equipment.
- J. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1-mil-thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.
- K. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water.
- L. Factory Insulated Equipment: Do not insulate.
- M. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- N. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- O. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- P. Insulated equipment containing fluids below ambient temperature: Insulate entire system.
- Q. Mineral fiber insulated equipment containing fluids below ambient temperature: Provide vapor retarder jackets, factory-applied or field-applied. Finish with glass-cloth and vapor barrier adhesive.
- R. For hot equipment containing fluids over 140 deg F insulate flanges and unions with removable sections and jackets.
- S. Mineral fiber insulated equipment containing fluids above ambient temperature: Provide standard jackets, with or without vapor retarder, factory-applied or field-applied. Finish with glass cloth and adhesive.
- T. Finish insulation at supports, protrusions, and interruptions.

- U. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or PVC jacket and fitting covers.
- V. Nameplates and ASME Stamps: Bevel and seal insulation around; do not insulate over.
- W. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
- X. Insulated ductwork conveying air below ambient temperature:
 - 1. Provide insulation with vapor retarder jackets.
 - 2. Finish with tape and vapor retarder jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- Y. Insulated ductwork conveying air above ambient temperature:
 - 1. Provide with or without standard vapor retarder jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- Z. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting or aluminum jacket.
- AA. Exterior Applications: Provide insulation with vapor retarder jacket. Cover with caulked anodized aluminum jacket with seams located on bottom side of horizontal duct section.
- BB. External Duct Insulation Application:
 - 1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
 - 2. Secure insulation without vapor retarder with staples, tape, or wires.
 - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
 - 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
 - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- CC. Duct and Plenum Liner Application:
 - 1. Adhere insulation with adhesive for 100 percent coverage.
 - 2. Secure insulation with mechanical liner fasteners. Follow SMACNA Standards for spacing.
 - 3. Seal and smooth joints. Seal and coat transverse joints.
 - 4. Seal liner surface penetrations with adhesive.
 - 5. Duct dimensions indicated are net inside dimensions required for airflow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

- A. Pipe Insulation:
 - 1. Hydronic Heating Piping:
 - a. 1-1/2-Inch Pipe and Smaller: Fiberglass, 2 inches thick.
 - b. 2-Inch to 6-Inch Pipe: Fiberglass, 3 inches thick.
 - 2. Piping Subject to Freezing Ambient Temperatures, All Pipe Sizes: Fiberglass, 2 inches thick.

3. Hot Equipment: Fiberglass, 2 inches thick.
 4. Exterior Fuel Piping: Closed cell rubber foam, 1 inch thick.
- B. Duct Insulation and Lining:
1. Exhaust Ducts Within 3 Feet of Exterior Openings:
 - a. Rigid Glass Fiber Ductwork Insulation: 2 inches thick.
 2. Outside Air Intake Ducts:
 - a. Rigid Glass Fiber Ductwork Insulation: 2 inches thick.
 3. Outside Air Plenums:
 - a. Rigid Glass Fiber Ductwork Insulation: 2 inches thick.
 4. Engine Exhaust Piping and Silencers:
 - a. 2 inches calcium silicate with aluminum jacketing.
 5. Provide additional insulation as noted on the Drawings.

END OF SECTION

SECTION 23 08 00
COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 SUMMAR

- A. Section Includes:
 - 1. HVAC commissioning description.
 - 2. HVAC commissioning responsibilities.
- B. Related Sections:
 - 1. Section 01 91 00 - Commissioning.
 - 2. Section 22 08 00 - Commissioning of Plumbing: Plumbing systems commissioning requirements.
 - 3. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC: For requirements and procedures concerning testing, adjusting, and balancing of mechanical systems.
 - 4. Section 23 09 33 - Electric and Electronic Control System for HVAC: Submittal, training, and programming requirements.
 - 5. Section 23 33 00 - Air Duct Accessories: Product requirements for ductwork test holes.

1.2

- A.

1.3

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE Guideline 1 - The HVAC Commissioning Process.
- B. Building Commissioning Association:
 - 1. BCA - Commissioning Handbook.
- C. National Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Building Systems Commissioning.
- D. Testing Adjusting and Balancing Bureau:
1. TABB - Commissioning Manual.

1.4 COMMISSIONING

- A. HVAC commissioning process includes the following tasks:
1. Testing and startup of HVAC equipment and systems. Equipment and
 2. system verification checks.
 3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
 4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
 5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
 6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
 7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
 8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
 9. Provide training for systems specified in this Section with coordination by Commissioning Authority.
- B. Equipment and Systems to Be Commissioned:
1. New HVAC systems that were installed under this Contract.
- C. The following is a partial list of equipment that may be included in this HVAC Commissioning:
1. Fuel oil systems.
 2. Fuel fired heaters.
 3. Piping systems.

4. Ductwork. Fans.
 5. Automatic HVAC control system.
 6. Testing, Adjusting and Balancing work.
 - 7.
- D. Special considerations, specific functional test requirements:
1. In addition to functional test of the equipment listed above, and tests in accordance with industry standards, include the following:
 2. Test of fuel oil return piping flow with fuel oil supply pump running after day tank full level is reached (overflow test). **TAKE PRECAUTIONS TO AVOID A SPILL OF FUEL OIL.**

1.5 COMMISSIONING

- A. Buy American Compliance
1. All submittals shall include a manufacturer or supplier certification or other evidence that products meet Buy America Preference requirements of the project. This may include evidence the product was submitted in an approved Type 3 or Type 4 waiver request prior to contract award. Submittals without the certification or other evidence indicating compliance will be rejected without further review.
- B. Section 01 91 00 - Commissioning: Requirements for commissioning submittals.
- Draft Forms: Submit draft of system verification form and functional performance test checklist.
- C. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified.
- D. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.
- E.

1.6 CLOSEOUT SUBMITTALS

- A. GCP 60-08 - Submittal Procedure: Requirements for submittals.
- B. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.
- C. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with Section 01 91 00.

1.8 COMMISSIONING

- A. Equipment or System Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
 2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
 3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
 4. Provide instructions and demonstrations for Owner's personnel.
 5. Ensure subcontractors perform assigned commissioning responsibilities.
 6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
 7. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned. If manufacturer's startup procedures are not available, provide in accordance with accepted industry practice.
 8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
 9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
 10. Provide representatives experienced with operation of equipment to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
 11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
 12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.
 13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.

14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
15. Perform verification checks and startup on equipment and systems as specified.
16. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
17. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
18. Conduct HVAC system orientation and inspection.

B. Temperature Controls Installer Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Review design for ability of systems to be controlled including the following:
 - a. Confirm proper hardware requirements exists to perform functional performance testing.
 - b. Confirm proper safeties and interlocks are included in design.
 - c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
 - d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
Confirm sensors selected are within device ranges.
 - e. Review sequences of operation and obtain clarification from Architect/Engineer.
 - f. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
 - g.
3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.

4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.
6. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan and requirements of Section 23 05 01.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.9 COMMISSIONING

- A. Section 01 91 00 - Commissioning: Requirements for commissioning meetings.
- B. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.10 COORDINATION

- A. GCP 50 Control of Work: Requirements for coordination.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 INSTALLATIO

- A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required to meet performance requirements.

- B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.
- C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.
- D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements. Refer to Section 23 33 00.
- E. Prior to start of functional performance test, install replacement filters in equipment.

END OF SECTION

SECTION 23 09 00
INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Air supply piping and tubing.
2. Control panel enclosures.
3. Thermostats.
4. Time clocks.
5. Alarm system.
6. Control air dampers.
7. Electric damper actuators.
8. Control valves.
9. Electric valve actuators.
10. Outside air measuring and modulation device.
11. Direct digital control system components.
12. Duct-mounted smoke detector.
13. Differential pressure monitor.

1.02 REFERENCES

A. Air Movement and Control Association International, Inc.:

1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.

C. American Society of Mechanical Engineers:

1. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.

D. ASTM International:

1. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536 - Standard Specification for Ductile Iron Castings.
3. ASTM B32 - Standard Specification for Solder Metal.
4. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
5. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
6. ASTM D2737 - Standard Specification for Polyethylene (PE) Plastic Tubing.

E. American Welding Society:

1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.

- F. National Electrical Manufacturers Association:
 - 1. NEMA DC 3 - Residential Controls - Electrical Wall Mounted Room Thermostats.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- G. National Fire Protection Association:
 - 1. NFPA 72 - National Fire Alarm Code.
 - 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
- H. Underwriters Laboratories, Inc.:
 - 1. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics.

1.03 SUBMITTALS

- A. Section 01 33 00 – Submittal Procedures: Submittal procedures.
- B. Product Data: Submit description and engineering data for each control system component. Include sizing as requested.
- C. Shop Drawings: Indicating occupancy sensor type, location, and coverage.

1.04 CLOSEOUT SUBMITTALS

- A. Section 01 77 00 - Contract Closeout Procedures: Closeout procedures.
- B. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors.
- C. Operation and Maintenance Data: Submit inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

1.05 QUALITY ASSURANCE

- A. Control Air Damper Performance: Test in accordance with AMCA 500.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years' experience.
- B. Installer: Company specializing in performing Work of this Section with minimum three years' experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Material and Equipment: Product storage and handling requirements.

1.08 COORDINATION

- A. Section 01 31 14 – Work Coordination: Requirements for coordination.
- B. Coordinate installation of control components in piping systems with work of Section 23 21 16 – Hydronic Piping Specialties.

- C. Coordinate installation of control components in duct systems with work of Section 23 33 00 – Air Duct Accessories.

1.09 MAINTENANCE SERVICE

- A. Section 01 73 00 - Execution Requirements: Requirements for maintenance service.

PART 2 - PRODUCTS

2.01 THERMOSTATS

- A. Electric Thermostats:
 - 1. Type: NEMA DC 3, 24 volts.
 - 2. Service: heating.
 - 3. Covers: Locking with set point adjustment and thermometer.
- B. Line Voltage Thermostats:
 - 1. Integral manual On/Off/Auto selector switch, single or two-pole.
 - 2. Dead band: Maximum 2 deg F.
 - 3. Cover: Locking with set point adjustment and indication, as well as space temperature indication.
- C. Room Thermostat Accessories:
 - 1. Insulating Bases: For thermostats located on exterior walls.
- D. Immersion Thermostat: Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

2.02 CARBON MONOXIDE DETECTOR

- A. Detects carbon monoxide, with a range of 0 to 400 ppm, accurate to plus or minus 3 percent within this range (display to nearest 1 percent).
- B. Audible alarm capability.
- C. Adjustable set point.

2.03 NITROGEN DIOXIDE DETECTOR

- A. Detects nitrogen dioxide, with a range of 0 to 10 ppm, accurate to plus or minus 5 percent within this range (display to nearest 1 percent).
- B. Audible alarm capability.
- C. Adjustable set point.

2.04 ALARM SYSTEM

- A. Furnish alarm panel with individual indication, horn, silenced acknowledge switch, and test switch.

- B. At alarm condition indication, light flashes and alarm sounds. Horn stops when acknowledge switch is pushed and system indicates alarm conditions by continuous light until trouble condition has cleared. Alarm sounds again when second alarm occurs before first one has cleared.

2.05 ELECTRIC DAMPER ACTUATORS

- A. Operation: Two-position or modulating as noted in the sequence.
 - 1. Where noted in the sequence, actuators shall have spring fail capabilities.
- B. Mounting: Direct mount.
- C. Stroke: 90 seconds end to end full stroke, 15 seconds return to normal for spring return.
- D. Protection: Electronic stall protection.
- E. Control Input: 0-10 VDC or 0-20 mADC.
- F. Torque: Size for minimum 150 percent of required duty.
- G. Duty Cycle: Rated for 65,000 cycles.

2.06 INDOOR OCCUPANCY SENSORS

- A. General Requirements for Sensors:
 - 1. Wall or ceiling-mounted, solid-state indoor occupancy sensors.
 - 2. Passive infrared, ultrasonic, or dual technology.
 - 3. Low voltage input, 24 VAC or VDC.
 - 4. Integrated or separate power pack.
 - 5. Hardwired connection to DDC.
 - 6. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 7. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, notify DDC when coverage area is occupied; with a time delay for turning lights off, adjustable over a minimum range of 15 to 30 minutes.
 - 8. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A or sensor is powered from the power pack.
 - 9. Power: Line voltage.
 - 10. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - 11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - 12. Bypass Switch: Override the "on" function in case of sensor failure.
- B. PIR Type: Wall or ceiling] mounted; detect occupants in coverage area by their heat and movement.
 - 1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.
- C. Ultrasonic Type: Wall or ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
 5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
 6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 84 inches above finished floor.
- D. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
 4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify building systems to be controlled are ready to operate.
- B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings before installation.

3.02 INSTALLATION

- A. Install thermostats, humidistats, space temperature sensors, carbon monoxide detectors, and other exposed control sensors 60 inches above floor.

- B. Install and aim occupancy sensors to provide not less than 90 percent coverage of the areas served by their associated HVAC equipment. Install extreme-temperature occupancy sensors in parking bay areas.
- C. Install conduit and electrical wiring in accordance with Division 26.
- D. Mount control panel on vibration free wall or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

3.03 POWER AND INTERFACE CONNECTIONS

- A. Coordinate fully with other Divisions of this specification to provide all necessary power connections and interface connections for a complete and fully operable monitoring system.

3.04 FIELD QUALITY CONTROL

- A. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

3.05 DEMONSTRATION AND TRAINING

- A. Section 01 79 00 – Demonstration and Training: Requirements for demonstration and training.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. Demonstrate complete operation of systems, including sequence of operation prior to Date of Substantial Completion.
- D. Demonstrate complete and operating system to DEPARTMENT.

END OF SECTION

SECTION 23 09 23
DIRECT-DIGITAL CONTROL SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. The HVAC DDC system manufacturer shall furnish and install a fully integrated building automation system, incorporating direct digital control (DDC) for energy management, equipment monitoring, and control, and subsystems as herein specified. The CONTRACTOR shall provide a complete temperature control system as specified herein. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, bill of materials, component designation or identification number, and sequence of operation all bearing the name of the manufacturer. This shall include but not be limited to all relays, alarm contacts, and sensors required for interface with other HVAC equipment specified in other sections of Divisions 21, 22, and 23.
- B. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom-designed especially for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.
- C. HVAC DDC system manufacturer shall be responsible for all HVAC DDC system and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with Division 26 of the Specifications and all local and national codes.
- D. The Controls Subcontractor shall be a member of the CONTRACTOR's commissioning team shall be responsible for providing all labor, materials, equipment, etc., required within the scope of this specification to facilitate the commissioning process. The commissioning members of the commissioning team shall perform all test and verification procedures required by the commissioning process when requested by the HVAC Commissioning Authority and as directed by the General CONTRACTOR. Section includes control equipment and software. CONTRACTOR shall provide and install all controls equipment, sensors, panels, actuators, control dampers, control valves, controllers, hardware, and software for a complete HVAC DDC system.

1.02 REFERENCES

- A. ASME MC85.1 (American Society of Mechanical Engineers) - Terminology for Automatic Control.
- B. NEMA EMC1 (National Electrical Mechanical Association) - Energy Management Systems Definitions.

1.03 SYSTEM DESCRIPTION

- A. Automatic temperature controls field monitoring and control system using field programmable microprocessor-based units.
- B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
- C. Provide computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
- D. Provide controls for radiation, duct coils, unit heaters, etc. when directly connected to control units.

- E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories to operate mechanical systems, and to perform functions specified.
- F. Provide installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.04 WORK BY OTHERS

- A. Mechanical contractor installs all wells, valves, taps, dampers, flow stations, etc.
- B. Electrical contractor provides:
 - 1. 120V dedicated power circuit to each DDC panel.
 - 2. Wiring of all power feeds through disconnect starters to electrical motors.
 - 3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by DDC manufacturer.
 - 4. Installation and wiring of duct smoke detectors.
 - 5. Power wiring of all smoke/fire dampers.
- C. Products furnished but not installed under this Section:
 - 1. Control valves.
 - 2. Temperature sensor wells and sockets.
 - 3. Control dampers (excludes factory mounted mixing box dampers).
- D. Products integrated to under this Section:
 - 1. Boiler Controls: Factory supplied boiler control panels shall interface with the building HVAC DDC system to give boiler burner status and trouble alarms.
 - 2. Fire Alarm/Lift Safety System: The DDC system shall communicate directly with the fire alarm/life safety system via dry contacts.
 - 3. Fuel Transfer Pumps and Day Tank: Factory supplied day tank, packaged transfer pump, and leak detection control panels shall interface with the building HVAC DDC system to give transfer pump status, day tank level and trouble alarms.
 - 4. DDC requirements per individual specification sections.

1.05 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions. Prior to installing the DDC systems, submit the following for review and approval.
- B. Shop Drawings: Indicate the following:
 - 1. Control system installation drawings showing the equipment controlled, the locations of field devices, field wiring, sequence of operation, and bill of materials.
 - 2. Schematic control diagrams. Clearly indicate set-points, reset schedules, switch over points, signal ranges, and other points required to completely describe the system.
 - 3. Complete controls wiring diagrams, architecture diagrams, and all penetration graphic screens (in color) for review and approval.
 - 4. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
 - 5. Connected data points, including connected control unit and input device.
 - 6. System graphics showing monitored systems, data (connected and calculated) point addresses, and operator notations. Submit demonstration diskette containing graphics.

7. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
- C. Product Data: Submit data for each system component and software module.
 1. Description and sequence of operation for operating, user, and application software.
 2. Control valve and control damper schedules.
 3. Product data/specification sheets for control system components and field devices.
- D. Performance testing and commissioning plans: Provide a detailed system DDC system start-up plan and checklist that verifies each point, sensor, device, and panel connection. System start-up plan shall include a final performance test plan that verifies the execution of all Sequences of Operation.
- E. Test Reports: Submit start-up, testing, commissioning, and demonstration certification reports.

1.06 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 – General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
 1. Revise shop drawings to reflect actual installation and operating sequences.
 2. Submit data specified in "Submittals" in final "Record Documents" form.
 3. Provide a complete database backup CD ROM for the building management system and each direct digital controller to the DEPARTMENT at final inspection. If software modifications are required during the warranty period, update backup CD-ROM. Backup CD-ROM shall also contain a complete set of system color graphic of the graphic floor penetration, system graphic displays, and wiring diagrams.
- C. Operation and Maintenance Data:
 1. Index sheet, listing contents in alphabetical order.
 2. Manufacturer's equipment parts list of all functional components of the system.
 3. Description of sequence of operations.
 4. As-built interconnection wiring diagrams.
 5. Operator's Manual.
 6. Hardware and software manuals.
 7. Trunk cable schematic showing panel locations and all trunk data.
 8. List of connected data points, including panels and input device (ionization detector, sensors, etc.) to which they are connected. Submit interconnection wiring diagrams complete field installed systems with identified and numbered system components and devices.
 9. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
 10. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- D. Certified copy of the final DDC performance testing stating the hardware and software performs as specified and system functions according to the Sequence of Operation.

1.07 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience and is manufacturer-authorized.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 DIRECT DIGITAL CONTROLS

- A. Manufacturers: Siemens, Schneider Electric, Honeywell, or Delta.

2.02 OPERATOR STATION

- A. Provide new 24" touchscreen wall-mounted all in one workstation computer in each building.

2.03 CONTROL UNITS

- A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.
- B. Battery Backup: For minimum of 12 hours for complete system including RAM without interruption, with automatic battery charger.
- C. Control Units Functions:
 - 1. Monitor or control each input/output point.
 - 2. Completely independent with hardware clock/calendar and software to maintain control independently.
 - 3. Acquire, process, and transfer information to operator station or other control units on network.
 - 4. Accept, process, and execute commands from other control unit's or devices or operator stations.
 - 5. Access both database and control functions simultaneously.
 - 6. Record, evaluate, and report changes of state or value occurring among associated points. Continue to perform associated control functions regardless of status of network.
 - 7. Perform in stand-alone mode:
 - a. Start/stop.
 - b. Duty cycling.
 - c. Automatic Temperature Control.
 - d. Demand control via a sliding window, predictive algorithm.
 - e. Event initiated control.
 - f. Calculated point.
 - g. Scanning and alarm processing.
 - h. Full direct digital control.
 - i. Trend logging.
 - j. Global communications.
 - k. Maintenance scheduling.
- D. Global Communications:
 - 1. Broadcast point data onto network, making information available to other system controls units.
 - 2. Transmit input/output points onto network for use by other control units and use data from other control units.

- E. Input/Output Capability:
 - 1. Discrete/digital input (contact status).
 - 2. Discrete/digital output.
 - 3. Analog input.
 - 4. Analog output.
 - 5. Pulse input (5 pulses/second).
 - 6. Pulse output (0-655 seconds in duration with 0.01-second resolution).
- F. Monitor, control, or address data points. Include analog inputs, analog outputs, pulse inputs, pulse outputs, and discrete inputs/outputs. Furnish control units with minimum 30 percent spare capacity.
- G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to 250 seconds.
- H. Upload/Download Capability: Download from or upload to operator station. Upload/Download time for entire control unit database maximum 10 seconds on hard-wired LAN or 60 seconds over voice-grade phone lines.
- I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of control algorithms on line without disrupting field hardware and controlled environment. In test mode:
 - 1. Inhibit scanning and calculation of input points. Issue manual control to input points (set analog or digital input point to operator determined test value) from workstation.
 - 2. Control output points but change only database state or value; leave external field hardware unchanged.
 - 3. Enable control-actions on output points but change only data base state or value.
- J. Local display and adjustment panel: Integral to control-unit containing digital display, and numerical keyboard. Display and adjust:
 - 1. Input/output point information and status.
 - 2. Controller set points.
 - 3. Controller tuning constants.
 - 4. Program execution times.
 - 5. High and low limit values.
 - 6. Limit differential.
 - 7. Set/display date and time.
 - 8. Control outputs connected to the network.
 - 9. Automatic control outputs.
 - 10. Perform control unit diagnostic testing.
- K. Points in "Test" mode.

2.04 LOCAL AREA NETWORKS

- A. Furnish communication between control units over local area network (LAN).
- B. LAN Capacity: Not less than 60 stations or nodes.
- C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
- D. LAN Data Speed: Minimum 28.8 Kb.
- E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.

- F. Transmission Medium: Fiber optic or single pair of solid 24-gauge twisted, shielded copper cable.
- G. Network Support: Time for global point to be received by any station, less than 3 seconds. Furnish automatic reconfiguration when station is added or lost. In event transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.05 CONTROL PANELS

- A. All controllers, relays, switches, etc., shall be mounted in enclosed control panels with hinged and locking doors. All operating and indicating devices shall be flush mounted on the face of the control panel doors, as required by the sequence of operation.
- B. All control devices located in exposed areas subject to outside weather conditions shall be mounted inside weatherproof enclosures. Location of each panel shall be convenient for adjustment service.
- C. Nameplates shall be provided beneath each panel face mounted control device describing the function of each device. Nameplates shall have white letters engraved on blue Lamicoid, or approved equal.
- D. All control panels shall bear a UL label compatible with the application.
- E. All electrical devices within the panel shall be prewired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.

2.06 ELECTRIC CONTROLLERS

- A. Each electronic controller shall provide a proportional output signal.
- B. Electronic controllers shall include a separate output proportional to setpoint deviation, to provide input to sequence controllers and other auxiliary functions. A calibrated setpoint adjustment shall be provided.
- C. Each controller shall be provided with a permanent diagram of calibration and termination details. All adjustments shall be accessible. The output of all controllers shall be short-circuit proof. All system components shall be capable of working in ambient temperatures of 32 deg F to 140 deg F.
- D. Auxiliary Controllers:
 - 1. Auxiliary controllers shall provide two additional output stages for sequence of operation of two independent control loops or for sequence control in common loop. The deviation signal from the master controller shall be proportional. The module shall provide separate adjustments for start point and throttling range.
 - 2. High/low selector controllers shall compare the deviation signals from two controllers and, depending on the selection (hi/lo), feed to the output stage. The output shall be directly or inversely proportional to the input signal.
 - 3. Low temperature controllers shall indicate a temperature deviation when a pre-selected alarm setpoint is exceeded. The temperature signal shall have either an independent sensor or a parallel hook-up with the controller sensor. Adjustments will be made available on the face of the module to set high and low alarm settings. There shall be two internal SPDT relays to operate external alarm circuits.
 - 4. Analog temperature indicator controllers shall be used in conjunction with a temperature controller or to a dedicated sensor and shall provide suitable ranges for the application.

2.07 TRANSMITTERS

- A. Provide duct and immersion temperature transmitters of the liquid-filled capillary type, incorporating a feedback signal to insure an exact and proportional relation between the measured temperature and the transmitted signal. Where the transmitter is used for sensing of mixed-air temperature of coil discharge temperatures, and/or the duct area is in excess of 14 sq. ft., the instrument shall incorporate an averaging element. This element shall be a minimum of 96 inches long. Outside air sensing shall be accomplished using a transmitter shielded from the effects of sunlight.
- B. To limit the total control loop error and provide closer control, transmitter shall be furnished in the following ranges:
 - Mixed Air..... 0 to 100 deg F
 - Outside Air Minus 60 to 125 deg F
 - Hot Water/Glycol 40 to 240 deg F
 - Room Temperature 55 to 85 deg F
 - Return/Supply Air 40 to 150 deg F
- C. Manufacturers not having the above ranges shall provide industrial transmitters bench-calibrated for the particular range. Calibration certificate shall be furnished with each device.
- D. Where transmitters are used for sensing liquid temperatures, provide with brass separable wells.

2.08 SENSORS

- A. All electronic temperature sensors shall be standard resistance type for all temperature ranges. All electronic temperature sensors shall be factory calibrated and of tamper proof construction requiring no field calibration. Temperature sensor accuracy shall be a minimum of plus 1 percent. To ensure system accuracy, a common sensor shall be used for each control loop to provide control, indication (local and central), alarm indication (local and central) and where multi-control functions, such as discharge temperature control with compensation and positive high and low limits are used.
- B. Where the sensor is used for sensing of mixed air temperature or coil discharge temperatures, and/or the duct area cross-section is in excess of 14 sq. ft., the instrument shall incorporate an averaging element. This element shall be a minimum of 96 inches long. Outside air sensing shall be accomplished using a sensing element and transmitter shielded from the effects of sunlight.
- C. Sensors shall be furnished in scale ranges compatible with system operating range.
- D. Where sensors are used for sensing liquid temperatures, they shall be furnished with brass separable wells.

2.09 DIRECT READING PRESSURE DIFFERENTIAL GAUGES

- A. Gauges shall be panel-mounted with the appropriate sensing tubes located on the equipment being measured. Differential pressure gauges shall be of the high-sensitivity bellows-actuated variety. The range of differential pressure gauges shall be appropriate for the pressure drop being measured.

2.10 RELAYS AND SIGNAL TRANSMITTERS

- A. All necessary relays and signal boosters shall be furnished to make the system a full and operable system as required by the sequence of operation.

2.11 AUTOMATIC CONTROL VALVES

- A. All automatic control valves shall be fully proportioning with modulating plugs for equal percentage of linear flow characteristics. The valves shall be sized by the control manufacturer and be provided with actuators of sufficient power for the duty intended. Valve body and actuator selection shall be sufficient to handle system pressure and shall close against the differential pressures expected to be encountered on the project.
- B. Where required by the sequence of operation, valves shall be capable of being sequenced with other valves or other pneumatically actuated devices. Where such sequencing is required, the actual spring range, when adjusted for spring shift, shall be such that no overlapping occurs. In the event that spring shift causes overlap, pilot positioning operators shall be furnished.
- C. Valves, 1/2-Inch through 1-Inch Diameter: Valves shall be constructed with a cast brass body and threaded ends. Trim shall consist of a removable cage providing valve plug guiding throughout the entire travel range. A stainless steel stem shall be provided. Bonnet, cage and the stem and plug assembly shall be removable for servicing. Actuator shall be cast aluminum with spring-return piston operated by synthetic rubber diaphragm. Body rating shall be 400 psi at 150 deg F. Cv factors for 1/2-inch diameter valves shall be field changeable by replacement of cage assembly. Two-way valve action (N.O., N.C.) shall be field changeable by replacement of stem and plug assembly. 1/2-inch diameter valves shall be available in Cv ratings of .2, .4, 1.2, 2.2, and 4.4.
- D. Valves, 1-1/2-Inch through 2-Inch Diameter: Valves shall be constructed with a cast brass body and threaded ends. For special duty, valves may be selected by the control manufacturer to have either bronze or cast-iron bodies with screwed or flanged ends. Valves shall have either piston or diaphragm actuators as required.
- E. Valves, 2-1/2-Inch Diameter and Above: Valves shall be constructed with a cast-iron body and have flanged connections. Actuators shall be of synthetic rubber, spring return, diaphragm type sized for duty.
- F. Valves shall be selected for maximum 2.5 psi pressure drop through valve at design flow.
- G. Unless otherwise noted, heating valves shall fail normally open, cooling valves normally closed.

2.12 HIGH AND LOW LIMIT THERMOSTATS

- A. Low limit thermostats shall employ a 20-foot element. If any 1-foot section of the element is subjected to temperatures below 35 deg F (adjustable), the respective electric or pneumatic circuit shall open causing action to fans and dampers as required under the sequence of operation.
- B. High limit thermostats shall employ rod and tube type elements, which extend approximately 10 inches into the duct. If instrument is subjected to temperatures above 135 deg F, action required by sequence of operations shall occur. Where high limit is required for fire protection, such thermostats shall be UL listed for fire protection.

2.13 AIR AND WATER FLOW PROOF DEVICES

- A. Airflow devices shall be differential pressure switching mechanisms.
- B. Water flow shall be differential pressure switches as required by sequence of operations.
- C. Paddle type flow switches are not acceptable.

2.14 SENSOR WELLS AND TAPS

- A. All hydronic sensors shall be installed in new wells or taps.
- B. All air system sensors shall be installed via new ductwork taps. Provide new mounting structures for new sensors.
- C. Wells and taps shall be provided by Controls Contractor and installed by Mechanical Contractor.

2.15 OPERATING SYSTEM SOFTWARE

- A. Input/Output Capability from Operator Station:
 - 1. Request display of current values or status in tabular or graphic format.
 - 2. User interface shall be web accessible. Contractor to coordinate with DEPARTMENT to verify controls monitoring software is compatible with the existing building systems management software.
 - 3. Controls software with communication capability shall be installed on DEPARTMENT specified SCADA computer.
 - 4. Building Automation controllers shall communicate via BACnet protocol with ethernet interface to control network.
 - 5. Command selected equipment to specified state.
 - 6. Initiate logs and reports.
 - 7. Change analog limits.
 - 8. Add, delete, or change points within each control unit or application routine.
 - 9. Change point input/output descriptors, status, alarm descriptors, and unit descriptors.
 - 10. Add new control units to system.
 - 11. Modify and set up maintenance scheduling parameters.
 - 12. Develop, modify, delete, or display full range of color graphic displays.
 - 13. Automatically archive select data even when running third party software.
 - 14. Capability to sort and extract data from archived files and to generate custom reports.
 - 15. Support two printer operations.
 - 16. Alarm printer: Print alarms, operator acknowledgments, action messages, system alarms, operator sign-on, and sign-off.
 - 17. Data printer: Print reports, page prints, and data base prints.
 - 18. Select daily, weekly, or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
 - 19. Print selected control unit database.
- B. Operator System Access: Via software password with minimum 30 access levels at workstation and minimum 3 access levels at each control unit.
- C. Database Creation and Support: Use standard procedures for changes. Control unit automatically checks workstation database files upon connection and verify database match. Include the following minimum capabilities:
 - 1. Add and delete points.
 - 2. Modify point parameters.
 - 3. Change, add, or delete English language descriptors.
 - 4. Add, modify, or delete alarm limits.
 - 5. Add, modify, or delete points in start/stop programs, trend logs, and other items.
 - 6. Create custom relationship between points.
 - 7. Create or modify DDC loops and parameters.
 - 8. Create or modify override parameters.
 - 9. Add, modify, and delete applications programs.
 - 10. Add, delete, develop, or modify dynamic color graphic displays.

- D. Dynamic Color Graphic Displays:
 - 1. Utilizes custom symbols or system supported library of symbols.
 - 2. Sixteen colors.
 - 3. Sixty outputs of real-time live dynamic data for each graphic.
 - 4. Dynamic graphic data.
 - 5. 1,000 separate graphic pages.
 - 6. Modify graphic screen refresh rate between 1 and 60 seconds.
- E. Operator Station:
 - 1. Accept data from LAN as needed without scanning entire network for updated point data.
 - 2. Interrogate LAN for updated point data when requested.
 - 3. Allow operator command of devices.
 - 4. Allow operator to place specific control units in or out of service.
 - 5. Allow parameter editing of control units.
 - 6. Store duplicate data base for every control unit and allow downloading while system is online.
 - 7. Control or modify specific programs.
 - 8. Develop, store and modify dynamic color graphics.
 - 9. Data archiving of assigned points and support overlay graphing of this data using up to four variables.
- F. Alarm Processing:
 - 1. Off Normal Condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state or value and alarms causing automatic dial-out.
 - 2. Critical Alarm or Change-of-State: Display message, stored on disk for review and sort, or print.
 - 3. Print one-line changeable message, up to 60 characters in length, for each alarm point specified.
 - 4. Display alarm reports on video. Display multiple alarms in order of occurrence.
 - 5. Define time delay for equipment start-up or shutdown.
 - 6. Allow unique routing of specific alarms.
 - 7. Operator specifies when alarm requires acknowledgment.
 - 8. Continue to indicate unacknowledged alarms after return to normal.
 - 9. Alarm notification.
 - 10. Print automatically.
 - 11. Display indicating alarm condition.
 - 12. Selectable audible alarm indication.
- G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change of state, specified state, or alarm occurrence or return to normal.
- H. Automatic Restart: Automatically start field equipment on restoration of power. Furnish time delay between individual equipment restart and time of day start/stop.
- I. Messages:
 - 1. Automatically display or print user-defined message subsequent to occurrence of selected events.
 - 2. Compose, change, or delete message.
 - 3. Display or log message at any time.
 - 4. Assign any message to event.

J. Reports:

1. Manually requested with time and date.
2. Long term data archiving to hard disk.
3. Automatic directives to download to transportable media including floppy diskettes for storage.
4. Data selection methods to include data base search and manipulation.
5. Data extraction with mathematical manipulation.
6. Data reports to allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four variables displayed.
7. Generating reports either normally at operator direction, or automatically under workstation direction.
8. Either manually display or print reports. Automatically print reports on daily, weekly, monthly, yearly, or scheduled basis.
9. Include capability for statistical data manipulation and extraction.
10. Capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.

K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

L. Data Collection:

1. Automatically collect and store in disk files.
2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2-year period.
3. Daily consumption for up to 30 meters over a 2-year period.
4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10-year period.
5. Archiving of stored data for use with system supplied custom reports.

M. Graphic Display: Support graphic development on workstation with software features:

1. Page linking.
2. Generate, store, and retrieve library symbols.
3. Single or double height characters.
4. Maximum of 128 dynamic points displayed on one screen.
5. Pixel level resolution.
6. Animated graphics for discrete points.
7. Analog bar graphs.
8. Display real time value of each input or output line diagram fashion.
9. Provide dynamic graphics with "system penetration" and "equipment location" methods of obtaining system information.
10. Provide dynamic graphic screens of mechanical equipment and DDC-controlled systems.

N. Maintenance Management:

1. Run time monitoring, for each point.
2. Maintenance scheduling targets with automatic annunciation, scheduling, and shutdown.
3. Equipment safety targets.
4. Display of maintenance material and estimated labor.
5. Target point reset, for each point.

O. Advisories:

1. Summary containing status of points in locked out condition.

2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
3. Report of power failure detection, time, and date.
4. Report of communication failure with operator device, field interface unit, point, and programmable control unit.

2.16 LOAD CONTROL PROGRAMS

- A. General: Support inch-pounds and SI metric units of measurement.
- B. Demand Limiting:
 1. Monitor total power consumption for each power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
 2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
 3. Forecast demand (kW): Predicted by sliding window method.
 4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between 1 and 255 minutes.
 5. Demand target: Minimum of three for each demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
 6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
 7. Limits: Include control band (upper and lower limits).
 8. Output advisory when loads are not available to satisfy required shed quantity, advise shed requirements.
- C. Duty Cycling:
 1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
 2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by equal quantity off portion is reduced.
 3. Set and modify following parameters for each individual load.
 - a. Minimum and maximum off time.
 - b. On/Off time in one-minute increments.
 - c. Time period from beginning of interval until cycling of load.
 - d. Manually override the DDC program and place a load in an On or Off state.
 - e. Cooling Target Temperature and Differential.
 - f. Heating Target Temperature and Differential.
 - g. Cycle off adjustment.
- D. Automatic Time Scheduling:
 1. Self-contained programs for automatic start/stop/scheduling of building loads.
 2. Support up to seven normal day schedules, seven "special day" schedules and two temporary day schedules.
 3. Special day's schedule supporting up to 30 unique date/duration combinations.
 4. Number of loads assigned to time program; with each load having individual time program.
 5. Each load assigned at least 16 control actions for each day with 1-minute resolution.
 6. Furnish the following time schedule operations:
 - a. Start.
 - b. Optimized Start.
 - c. Stop.
 - d. Optimized Stop.
 - e. Cycle.
 - f. Optimized Cycle.

7. Capable of specifying minimum of 30 holiday periods up to 100 days in length for the year.
 8. Create temporary schedules.
 9. Broadcast temporary "special day" date and duration.
- E. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
 2. Adaptive and self-tuning, adjusting to changing conditions unattended.
 3. For each point under control, establish and modify:
 - a. Occupancy period.
 - b. Desired temperature at beginning of occupancy period.
 - c. Desired temperature at end of occupancy period.
- F. Night Setback/Setup Program: Reduce heating space temperature set point or raise cooling space temperature set-point during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.
- G. Calculated Points: Define calculations and totals computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
 2. Treat calculated values like any other analog value; use for any function where a "hard wired point" might be used.
- H. Event Initiated Programming: Any data point capable of initiating event, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3,600 seconds.
 2. Output may be analog value.
 3. Provide for "skip" logic.
 4. Verify completion of one action before proceeding to next action. When not verified, program capable of skipping to next action.
 5. Direct Digital Control: Furnish with each control unit, Direct Digital Control software so operator is capable of customizing control strategies and sequences of operation by defining appropriate control loop algorithms and choosing optimum loop parameters.
 - a. Control Loops: Defined using "modules" that are analogous to standard control devices.
 6. Output: Paired or individual digital outputs for pulse width modulation, and analog outputs.
 7. Firmware:
 - a. PID with analog or pulse-width modulation output.
 - b. Floating control with pulse-width modulated outputs.
 - c. Two-position control.
 - d. Primary and secondary reset schedule selector.
 - e. Hi/Low signal selector.
 - f. Single pole double-throw relay.
 - g. Single pole double throw time delay relay with delay before break, delay before make and interval time capabilities.
 8. Direct Digital Control Loop: Downloaded upon creation or on operator request. On sensor failure, program executes user defined failsafe output.
 9. Display: Value or state of each of lines interconnecting DDC modules.

- I. Fine Tuning Direct Digital Control PID or Floating Loops:
 - 1. Display Information:
 - a. Control loop being tuned.
 - b. Input (process) variable.
 - c. Output (control) variable.
 - d. Set-point of loop.
 - e. Proportional band.
 - f. Integral (reset) interval.
 - g. Derivative (rate) interval.
 - 2. Display Format: Graphic, with automatic scaling; with input and output variable superimposed on graph of "time" versus "variable."
- J. Trend Logging:
 - 1. Each control unit capable of storing samples of control unit's data points.
 - 2. Update file continuously at operator assigned intervals.
 - 3. Automatically initiate upload requests and then stores data on hard disk.
 - 4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute.
 - 5. Coordinate sampling with specified on/off point- state.
 - 6. Display trend samples on workstation in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time versus data.

2.17 HVAC CONTROL PROGRAMS

- A. General:
 - 1. Support inch-pounds and SI metric units of measurement.
 - 2. Identify each HVAC Control system.
- B. Optimal Run Time:
 - 1. Control start-up and shutdown times of HVAC equipment for both heating and cooling.
 - 2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature.
 - 3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions.
 - 4. Use outside air temperature to determine early shut down with ventilation override.
 - 5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day.
 - 6. Operator Commands:
 - a. Define term schedule.
 - b. Add/delete fan status point.
 - c. Add/delete outside air temperature point.
 - d. Add/delete mass temperature point.
 - e. Define heating/cooling parameters.
 - f. Define mass sensor heating/cooling parameters.
 - g. Lock/unlock program.
 - h. Request optimal run-time control summary.
 - i. Request optimal run-time mass temperature summary.
 - j. Request HVAC point summary.
 - k. Request HVAC saving profile summary.

7. Control Summary:
 - a. HVAC Control system begin/end status.
 - b. Optimal run time lock/unlock control status.
 - c. Heating/cooling mode status.
 - d. Optimal run time schedule.
 - e. Start/Stop times.
 - f. Selected mass temperature point ID.
 - g. Optimal run-time system normal start-times.
 - h. Occupancy and vacancy times.
 - i. Optimal run time system heating/cooling mode parameters.
 8. Mass Temperature Summary:
 - a. Mass temperature point type and ID.
 - b. Desired and current mass temperature values.
 - c. Calculated warm-up/cool-down time for each mass temperature.
 - d. Heating/cooling season limits.
 - e. Break point temperature for cooling mode analysis.
 9. HVAC Point Summary:
 - a. Control system identifier and status.
 - b. Point ID and status.
 - c. Outside air temperature point ID and status.
 - d. Mass temperature point ID and status.
 - e. Calculated optimal start and stop times.
 - f. Period start.
- C. Supply Air Reset:
1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot deck and cold deck temperatures on dual duct and multi-zone systems, single zone unit discharge temperatures.
 2. Adjust discharge temperatures to most energy efficient levels satisfying measured load by:
 - a. Raising cooling temperatures to highest possible value.
 - b. Reducing heating temperatures to lowest possible level.
 3. Operator Commands:
 - a. Add/delete fan status point.
 - b. Lock/unlock program.
 - c. Request HVAC point summary.
 - d. Add/Delete discharge controller point.
 - e. Define discharge controller parameters.
 - f. Add/delete airflow rate.
 - g. Define space load and load parameters.
 - h. Request space load summary.
 4. Control Summary:
 - a. HVAC control system status (begin/end).
 - b. Supply air reset system status.
 - c. Optimal run time system status.
 - d. Heating and cooling loop.
 - e. High/low limits.
 - f. Deadband.

- g. Response timer.
 - h. Reset times.
5. Space Load Summary:
- a. HVAC system status.
 - b. Optimal run time status.
 - c. Heating/cooling loop status.
 - d. Space load point ID.
 - e. Current space load point value.
 - f. Control heat/cool limited.
 - g. Gain factor.
 - h. Calculated reset values.
 - i. Fan status point ID and status.
 - j. Control discharge temperature point ID and status.
 - k. Space load point ID and status.
 - l. Airflow rate point ID and status.
6. Control Summary:
- a. HVAC control system begin/end status.
 - b. Enthalpy switchover optimal system status.
 - c. Optimal return time system status.
 - d. Current outside air enthalpy.
 - e. Calculated mixed air enthalpy.
 - f. Calculated cooling coil enthalpy using outside air.
 - g. Calculated cooling coil enthalpy using mixed air.
 - h. Calculated enthalpy difference.
 - i. Enthalpy switchover deadband.
 - j. Status of damper mode switch.

2.18 PROGRAMMING APPLICATION FEATURES

A. Trend Point:

- 1. Sample up to 6 points, real or computed, with each point capable of collecting 100 samples at intervals specified in minutes, hours, days, or month.
- 2. Output trend logs as line-graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique color, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:

- 1. Allow definition of minimum of 10 messages, each having minimum length of 60 characters for each individual message.
- 2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totaled point's warning limit, and hardware elements advisories.
- 3. Output assigned alarm with "message requiring acknowledgment."
- 4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:

- 1. Automatically initiate equipment or system commands, based on selected time schedule for points specified.
- 2. Program times for each day of week, for each point, with one-minute resolution.
- 3. Automatically generate alarm output for points not responding to command.

4. Allow for holidays, minimum of 366 consecutive holidays.
 5. Operator Commands:
 - a. System logs and summaries.
 - b. Start of stop point.
 - c. Lock or unlock control or alarm input.
 - d. Add, delete, or modify analog limits and differentials.
 - e. Adjust point operation position.
 - f. Change point operational mode.
 - g. Open or close point.
 - h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
 - i. Begin or end point totals.
 - j. Modify total values and limits.
 - k. Access or secure point.
 - l. Begin or end HVAC or load control system.
 - m. Modify load parameter.
 - n. Modify demand limiting and duty cycle targets.
 6. Output Summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.
- D. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
 2. Binary contact, high/low limit of analog point or computed point capable of being used as master. Master capable of monitoring or commanding multiple slaves.
 3. Operator Commands:
 - a. Define single master/multiple master interlock process.
 - b. Define logic interlock process.
 - c. Lock/unlock program.
 - d. Enable/disable interlock process.
 - e. Execute terminate interlock process.
 - f. Request interlock type summary.
- E. Alphanumeric Pager Alarm Software (Auto-Dialer): Provide a Windows-based alarm software package to direct critical alarm messages to an alphanumeric pager or page capable telephone. The software shall receive all alarm messages generated by the system and selectively route the alarm messages to one or more pages. User defined filters shall control when and to whom alarm messages are sent.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify conditioned power supply is available to control units and to operator workstation.
- B. Verify field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION

- A. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93 - Sequence of Operations for HVAC Controls.

- C. Install with 120 volts AC, 15 amp dedicated emergency power circuit to each programmable control unit.
- D. Install electrical material and installation in accordance with appropriate requirements of Division 26.
- E. Locate outdoor temperature sensor outside on the north side of the building with appropriate shading.

3.03 COMMISSIONING, TESTING, AND ACCEPTANCE

- A. Perform a three-phase commissioning procedure consisting of field I/O calibration and commissioning, system commissioning and integrated system program commissioning. Document all commissioning information on commissioning data sheets that shall be submitted prior to acceptance testing. Commissioning work that requires shutdown of system or deviation from normal function shall be performed when the operation of the system is not required.
- B. The commissioning shall be coordinated with the DEPARTMENT and construction manager to ensure systems are available when needed. Notify the operating personal in writing of the testing schedule so that authorized personnel from the DEPARTMENT and construction manager are present throughout the commissioning procedure.
 - 1. Prior to system program commissioning, verify that each control panel has been installed according to plans, specifications, and approved shop drawings. Test, calibrate and bring on line each control sensor and device. Commissioning shall include, but not be limited to:
 - a. Sensor range.
 - b. Verify analog limit and binary alarm reporting.
 - c. Point value reporting.
 - d. Binary alarm and switch settings.
 - e. Actuator ranges.
 - f. Fail safe operation on loss of control signal, electric power, and network communications.
- C. After control devices have been commissioned (i.e., calibrated, tested and signed off), each BMS program shall be put on line and commissioned. The CONTRACTOR shall, in the presence of the DEPARTMENT'S Representative, demonstrate each programmed sequence of operation and compare the results with the specified sequence. In addition, each control loop shall be tested to verify proper response and stable control. System test results shall be recorded on CONTRACTOR-generated commissioning data sheets and submitted for record. Any discrepancies between the specification and the actual performance will be immediately rectified.
- D. After all BMS programs have been commissioned, the CONTRACTOR shall verify the overall system performance as specified. Tests shall include, but not be limited to:
 - 1. Data communication, both normal and failure modes.
 - 2. Fully loaded system response time.
 - 3. Sequence of Operations execution.
 - 4. Impact of component failures on system performance and system operation.
 - 5. Time/Date changes.
 - 6. End of month/ end of year operation.
 - 7. Season changeover.
 - 8. Global application programs and point sharing.
 - 9. System backup and reloading.
 - 10. System status displays.
 - 11. Diagnostic functions.
 - 12. Power failure routines.
 - 13. Battery backup.

- E. Submit for approval a detailed acceptance test procedure designed to demonstrate compliance with contractual requirements. This Acceptance test procedure will take place after the commissioning procedure but before final acceptance, to verify that sensors and control devices maintain specified accuracies and the system performance does not degrade over time.
- F. Using the commissioning test data sheets, CONTRACTOR shall demonstrate each point and system function. Completed test data sheets shall be made available to the DEPARTMENT if requested.

3.04 TRAINING

- A. Coordinate training with requirements of Section 22 00 00 - General Mechanical Requirements. The manufacturer shall provide a trained instructor to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach and shall be approved by the DEPARTMENT.

END OF SECTION

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SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes sequence of operation for:

1. Exhaust fans.
2. Make-up air unit.
3. Heat recovery unit.
4. Ceiling fans.
5. Boilers.
6. Pumps.
7. Glycol make-up tank.
8. Unit heaters and cabinet unit heaters.
9. Central fan systems.
10. Radiant panels and finned tube.
11. Oil water separator and sump pump.
12. Shop air compressor.

1.02 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: 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 00 - Instrumentation and Control for HVAC, Section 23 09 23 - Direct Digital Control System, and within this Section.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 SCHEDULE

A. The Contractor shall collaborate with the Department directly to determine the Department's preference for naming conventions, etc., before entering the data into the system. Work outlined here shall be controlled by the DDC system unless otherwise noted. Suggested set points and settings shall be adjustable.

B. Occupancy shall be determined by occupancy sensors.

3.02 EXHAUST FAN (EF-1, 2, 3, 4, 5, 6, 7, AND 8; INDICATED AS 1 BELOW FOR CONCISENESS)

A. The bay area exhaust fans, EF-, shall be provided with a positive shut-off control damper. The unit shall be DDC controlled using electric actuation. EF- shall operate, and the positive shut-off damper shall open whenever:

1. The building is occupied as determined by the occupancy sensors. EF- shall operate at approximately 20% or as required to match the minimum speed of MAU-1.

2. When a CO detector senses 25 ppm (adjustable) CO concentrations or above the exhaust fan speed shall increase to its maximum (scheduled) cfm.
 3. When a space NO2 detector senses 5 ppm (adjustable) NO2 concentrations or above the exhaust fan speed shall increase to its maximum cfm.
 4. The minimum run time upon EF- activation is 20 minutes (adjustable). EF- shall be off when unoccupied and with CO and NO2 detected levels below 15 ppm (adjustable) and 2 ppm (adjustable) respectively and after the minimum run time has elapsed.
- B. Make-up air will be provided by MAU-1, which will operate to maintain static pressure set point whenever EF- is on its associated VAVs shall modulate make up air volume in relation to exhaust fan speed.
- C. Provide a one-hour timer wall switch in the equipment storage area with the following on/off control:
1. On: EF- shall operate at full speed. MAU-1 shall operate.
 2. Off: Control of EF-, and MAU-1 shall return to CO detection/DDC control.
- D. Safety:
1. Whenever the CO concentration is above the set point 25 ppm (adjustable) or NO2 concentration is above 100 ppm (adjustable) for more than five minutes from any detector an audible alarm shall sound.
 2. Whenever CO or NO2 concentrations call for EF- activation and EF- fails to activate, an audible alarm shall sound. Provide 30 second delay to reduce nuisance alarms.
- E. A current switch is installed in the exhaust fan starter. The DDC system uses this switch to confirm the fan is in the desired state (i.e., on or off) and generates a DDC alarm if status deviates from DDC start/stop control.
- F. DDC Alarm, Status, Control, and Monitoring Points:
1. EF- Status (on/off).
 2. EF- Control (on/off).
 3. EF- Failure (alarm).
 4. CO levels (ppm).
 5. NO2 levels (ppm).

3.03 MAKE UP AIR UNIT (MAU-1)

- A. Unit shall operate when EF-1 through 8 is in operation and shall be off when EF-1-8 is off is off. The unit shall be DDC-controlled.
- B. On Mode: Outdoor air damper shall be open and the fan shall modulate to maintain static pressure its associated VAVs shall modulate to match the air flow rate of its corresponding exhaust fan(s).
- C. Off Mode: Upon supply fan shut down, the outside air damper shall close.
- D. Hydronic heating coil (integral and provided with the unit) control valves shall modulate as required to maintain a supply air temperature from the MAU supply side according to the following schedule (adjustable):
1. Outside air temperature 20 deg F and above: 55 deg F.
 2. Outside air temperature below 20 deg F: 68 deg F.
- E. Safety:
1. An outdoor air damper end switch shall stop the supply fan whenever the outside air damper starts to close.
 2. A smoke detector in the supply air stream shall de-energize the supply fan upon activation and MAU-1 shall go to Off Mode.

- F. A current switch shall be installed in the supply fan starter. The DDC system shall use this switch to confirm the fan is in the desired state (i.e., on or off) and generate an alarm if status deviates from DDC start/stop control.
- G. DCC Alarm, Status, Control, and Monitoring Points:
 - 1. MAU-1 Status (on/off).
 - 2. MAU-1 Control (on/off).
 - 3. Supply air static pressure (inWC).
 - 4. Supply air discharge temperature (deg F).
 - 5. Supply air discharge set point (deg F).
 - 6. MAU-1 Failure (alarm).
 - 7. Supply air temperature low limit (alarm).
 - 8. MAU-1 pre-filter differential pressure (alarm).
 - 9. MAU-1 filter differential pressure (alarm).
 - 10. Pre-heat air temperature (deg F).
 - 11. OSA damper position (open/closed).
 - 12. Preheat coil valve (% open).
 - 13. Heat coil valve (% open).
- H. Provide the following equipment mounted devices:
 - 1. Outside air, supply air, exhaust air thermometers.
 - 2. Filter bank differential pressure gages (magnahelic).

3.04 VARIABLE AIR VOLUME BOXES (VAV-1, 2, 3, 4, 5 AND 6)

- A. VAV boxes shall modulate air flow rate to remain 5% lower than its associated EF/s.
- B. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. VAV Position Status (% open)
 - 2. VAV Position Setpoint (% open)
 - 3. VAV Flow Rate (cfm)

3.05 HEAT RECOVERY VENTILATOR (HRV-1 AND 2)

- A. Unit shall operate when the building is occupied as determined by the occupancy sensors or The minimum run time for HRV- shall be 1.5 hours.
- B. Unit shall be supplied with integral multi speed controller and contact to turn the unit on and off.
- C. Hydronic heating coil (PHC- and HC-) control valves shall modulate as required to maintain a supply air temperature from the HRV supply side according to the following schedule (adjustable):
 - 1. Outside air temperature 20 deg F and above: 55 deg F.
 - 2. Outside air temperature below 20 deg F: 70 deg F.
- D. The hydronic preheating coil PHC- shall modulate glycol flow through the coil to maintain a 35 deg F exhaust air temperature.
- E. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. HRV Status (on/off).
 - 2. HRV Control (on/off).
 - 3. Pre-heat air temperature (deg F).
 - 4. Supply air discharge temperature (deg F).
 - 5. Supply air discharge set point (deg F).
 - 6. Exhaust air discharge temperature (deg F).

7. OSA damper position (open/closed).
8. EA damper position (open/closed).
9. Preheat coil valve (% open).
10. Heat coil valve (% open).
11. HRV- Failure (alarm).
12. Supply air temperature low limit (alarm).
13. HRV- pre-filter differential pressure (alarm).

3.06 CEILING FANS, (CF-1 THROUGH 5)

- A. Unit shall be locally controlled through manufacturer-provided control panel located on the wall.

3.07 HEATING BOILERS (B-1A/B)

- A. Heating Boiler B-1A/B shall operate in a lead lag configuration.
- B. Heating Boiler B-1A/B and their associated control valves shall be controlled by the boiler manufacturer packaged control system and shall be monitored by the DDC system.
- C. If glycol return temperature drops below 130 deg F (adjustable), an alarm shall be generated.
- D. DDC Alarm, Status, Control, and Monitoring Points:
 1. B-1A status (on/off).
 2. B-1A fail (alarm).
 3. B-1B status (on/off).
 4. B-1B fail (alarm).
 5. GHS header temperature (deg F).
 6. GHR header temperature (deg F).
 7. B-1A GHS temperature (deg F).
 8. B-1B GHS temperature (deg F).
 9. Low glycol header supply temperature (alarm).

3.08 PUMPS

- A. System circulation pump (CP-1A/B) shall be activated during the heating season.
 1. DDC Alarm, Status, Control, and Monitoring Points:
 - a. CP-1A status (on/off).
 - b. CP-1A trouble (alarm).
 - c. CP-1B status (on/off).
 - d. CP-1B trouble (alarm).

3.09 GLYCOL MAKE-UP SYSTEM (GMT-1)

- A. The glycol make-up system pump shall provide glycol/water solution to the heating hydronic system as required by the system pressure sensor and make-up control valve.
- B. Packaged controller shall maintain system pressure at 15 psi (adjustable).
- C. If the tank controller's low-pressure alarm is generated, generate alarm through the BMS.
- D. DDC Alarm, Status, Control, and Monitoring Points: GMT-1 low pressure (alarm).

3.10 HYDRONIC UNIT HEATERS (UH-1 THROUGH UH-10) & ELECTRIC UNIT HEATER (EUH-1)

- A. DDC thermostat shall cycle fan and coil control valve, where applicable, as required to maintain setpoint temperature.
- B. If room temperature drops below 40 deg F, generate an alarm through the BAS.
- C. For unit heaters 1-10, provide a two-hour timer wall switch in the equipment storage area with the following on/off control for each unit heater:
 - 1. On: The unit heater fan shall run and its associated control valve shall open.
 - 2. Off: The unit heater fan and control valve shall be returned to temperature control.
- D. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. Room temperature (alarm).
 - 2. Room temperature (deg F).
 - 3. Room temperature setpoint.

3.11 RADIANT FLOOR ZONES (RM-1 THROUGH RM-14)

- A. During the heating season the radiant circulator pumps shall operate.
- B. DDC room temperature sensor shall open/close zone valves as required to maintain setpoint temperature.
- C. If room temperature drops below 40 deg F, generate an alarm through the BAS.
- D. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. Room temperature (alarm).
 - 2. Room temperature (deg F).
 - 3. Room temperature setpoint.
 - 4. Slab Temperature (deg F).

3.12 SUMP PUMP (SP-1 AND 2)

- A. Activate sump pump, SP-1, whenever the pump on/off float switch in the sump basin raises to the pump-on setpoint. Run SP-1 until the on/off float switch lowers below the pump-off setpoint.
- B. Initiate alarm sound and "SUMP HIGH WATER" DDC indicator upon sump basin high water alarm float rising to the high water alarm-on setpoint.
 - 1. Operator(s) shall manually activate the momentary local pump switch until the sump is pumped down.
- C. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. Sump Pump, SP-1,2 status (ON/OFF).
 - 2. Sump pump SP-1,2 control (ON/ODD)
 - 3. Sump basin high water alarm contact ("SUMP HIGH WATER").

3.13 OIL/WATER SEPARATOR

- A. Provided and controlled by manufacturer packaged control panel.
- B. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. Oil Water Separator, OWS-1, high oil level ("OWS-1 HIGH OIL").

3.14 MECHANICAL ROOM VENT FAN (VF-1)

- A. Mechanical room outside air intake dampers shall open and the fan shall modulate to maintain space temperature of 72 deg F (adjustable.) If space temperature falls below setpoint the fan shall turn off and remain off for 5 minutes (adjustable.)

3.15 AIR COMPRESSOR (AC-1)

- A. Provided and controlled by manufacturer packaged control panel.
- B. Initiate "SHOP AIR LINE PRESSURE LOW" DDC indicator upon pressure reading 5 psi below compressor-on setpoint.
- C. Initiate "SHOP AIR LINE PRESSURE HIGH" DDC indicator upon pressure reading 5 psi above compressor-off setpoint.
- D. DDC Alarm, Status, Control, and Monitoring Points:
 - 1. Shop Air Line Pressure:
 - a. Air Compressor Control (enable/disable).
 - b. Setpoint (psi).
 - c. Low alarm contact ("SHOP AIR LINE PRESSURE LOW").
 - d. High alarm contact ("SHOP AIR LINE PRESSURE HIGH").
 - 2. AC-1 Control (enable/disable).

3.16 VEHICLE EXHAUST FAN (EF-9)

- A. The vehicle exhaust fan, EF-9, shall be provided with a positive shut-off control damper. The unit shall be DDC controlled using electric actuation. EF-1 shall operate, and the positive shut-off damper shall open when enabled by either exhaust hose reel (EHR-1 and 2). A static pressure sensor on the inlet to the fan shall report back to DDC to prevent damage to the fan as a result of a plugged inlet. Static pressure set point 2.5" W.C. (adjustable).

END OF SECTION

SECTION 23 11 13
FACILITY FUEL-OIL PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 and 23 00 00 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Fuel-oil pipes, tubes, and fittings.
 - 2. Double-containment piping and fittings.
 - 3. Piping specialties.

1.03 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
 - 2. Include, where applicable, rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fuel-oil piping.
 - 1. Include plans, elevations sections, hangers, and supports for multiple pipes.
 - 2. Include details of location of anchors, alignment guides, and expansion joints and loops.
 - 3. Scale: 1/4 inch per foot.
- C. Coordination Drawings: Plans and details, drawn to scale, on which fuel-oil piping is shown and coordinated with other installations, using input from installers of the items involved.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications:
 - 1. Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code.
 - 2. Pipe welder to have a minimum of 3 years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store pipes and tubes with protective PE coating to avoid damaging the coating and to protect from direct sunlight.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with ASME B31.9, "Building Services Piping," for fuel-oil piping materials, installation, testing, and inspecting.
- C. Comply with requirements of the EPA and of state and local authorities having jurisdiction. Include recording of fuel-oil piping location.

2.02 PIPES, TUBES, AND FITTINGS ABOVE GRADE

- A. See "Outdoor Piping Schedule" and "Indoor Piping Schedule" articles for where pipes, tubes, fittings, and joining materials are applied in various services.
- B. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M, for butt and socket welding.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: Asbestos free, ASME B16.20 metallic, or ASME B16.21 nonmetallic, gaskets compatible with fuel oil.
 - e. Bolts and Nuts: ASME B18.2.1, cadmium-plated steel.

2.03 DOUBLE-WALL CONTAINMENT PIPE, FITTINGS, AND ACCESSORIES, ABOVE AND BELOW GRADE

- A. Manufacturers: Franklin Fueling Systems or equal.
- B. Pipe:
 - 1. Material:
 - a. Outer layer: High density polyethylene (HDPE) grade PE100.
 - b. Inner layer: Ethylene vinyl alcohol (EVOH) resin liner.
 - c. Intermediate layer: Tie-layer boning HDPE to EVOH layers.
 - 2. Double wall piping (pipe within a pipe) shall be available in stick or coil form.
 - 3. Temperature Rating: -22 to 122 deg F.

4. Pressure Rating:
 - a. Primary pipe: 90 psi.
 - b. Secondary pipe 58 psi.
 5. Connections electrofusion.
 6. Approvals: UL971.
- C. Fittings:
1. Electrofusion capable. Single piece primary pipe and two-piece outer pipe fittings.
 2. Material: PE100.
 3. Temperature rating: -40 to 122 deg F.
 4. Styles: Straight, reducing, 90-degree elbow, and 45-degree bend.
 5. UL Listed and EN14125 approved.
- D. Containment Sump Seal:
1. Electrofusion capable for pipe and containment sump.
 2. Material: PE100.
 3. Temperature rating: -40 to 122 deg F.
 4. Styles: Straight, reducing, 90-degree elbow, and 45-degree bend.
 5. UL Listed and EN14125 approved.
- E. Termination Fitting: HDPE over molded body with national pipe thread stainless steel insert.
- F. Containment Sump:
1. Body: One-piece high-density polyethylene construction.
 2. Lid: 23-1/2" watertight bolt down lid with handle.

2.04 PIPING SPECIALTIES

- A. Metallic Flexible Connectors:
1. Basis of Design: Franklin Fueling Systems Fireflex.
 2. Listed and labeled for aboveground and underground applications by an NRTL acceptable to authorities having jurisdiction.
 3. Stainless-steel bellows with woven, flexible, bronze or stainless-steel, wire-reinforcing protective jacket.
 4. Minimum Operating Pressure: 50 psig.
 5. End Connections: Socket, flanged, or threaded end to match connected piping.
 6. Maximum Length: 30 inches.
- B. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 3. Strainer Screen: 20-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
 4. CWP Rating: 125 psig.

2.05 JOINING MATERIALS

- A. Joint Compound and Tape for Threaded Joints: Suitable for fuel oil.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.06 SPECIALTY VALVES

A. Oil Safety Valves:

1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
2. Body: Aluminum or cast steel.
3. Springs: Stainless steel.
4. Seat and Diaphragm: Nitrile rubber.
5. Orifice: Stainless steel, interchangeable.
6. Factory-Applied Finish: Baked enamel.
7. Manual override port.
8. Maximum Inlet Pressure: 60 psig.
9. Maximum Outlet Pressure: 3 psig.

B. Emergency Shutoff (Fusible) Valves:

1. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
2. Single poppet valve.
3. Body: 316 stainless steel.
4. Disk: 303 stainless steel.
5. Poppet Spring: Stainless steel.
6. Shaft: Stainless steel.
7. O-Ring: Teflon or Viton.
8. Packing Nut: Stainless steel.
9. Fusible link to close valve at 165 deg F.

C. Anti-Siphon Valve:

1. Basis of Design: OPW 199ASV.
2. Listed and labeled for fuel-oil service by an NRTL acceptable to authorities having jurisdiction.
3. Cap and body: Aluminum, stainless steel, or iron.
4. Spring: Stainless steel.
5. Poppet: Aluminum or stainless steel.
6. Poppet seal: Viton.

D. Foot Valve:

1. Basis of Design: Morrison Bros. Model 934.
2. Body: Stainless steel.
3. Strainer Screen: 20 mesh stainless steel.
4. Seals: Viton.
5. Opening Pressure: Less than 1 psig.
6. Maximum Working Pressure: 200 psig.

2.07 LABELING AND IDENTIFYING

- ### **A. Detectable Warning Tape:** Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.01 EXAMINATION

- #### **A. Examine areas for compliance with requirements for installation tolerances and other conditions affecting performance of fuel-oil piping.**

- B. Examine installation of fuel-burning equipment and fuel-handling and storage equipment to verify actual locations of piping connections before installing fuel-oil piping.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Close equipment shutoff valves before turning off fuel oil to premises or piping section.
- B. Comply with NFPA 30 and NFPA 31 requirements for prevention of accidental ignition.

3.03 OUTDOOR PIPING INSTALLATION

- A. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining, to cover, seal, and protect joints.
 - 2. If there is PE coating damage, review protective coating damage with Engineer prior to repair. Replace damaged piping or repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- B. Install double-containment, fuel-oil pipe at a minimum slope of 1 percent downward toward fuel-oil storage tank sump.
- C. Install vent pipe at a minimum slope of 2 percent downward toward fuel-oil storage tank sump.
- D. Assemble and install entry boots for pipe penetrations through sump sidewalls for liquid-tight joints.
- E. Install metal pipes and tubes, fittings, valves, and flexible connectors at piping connections to AST and UST.
- F. Install fittings for changes in direction in rigid pipe.
- G. Install system components with pressure rating equal to or greater than system operating pressure.

3.04 INDOOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved by Engineer and included on Coordination Drawings if required.
- B. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings at a height that allows sufficient space for ceiling panel removal.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.

- H. Comply with requirements for equipment specifications for roughing-in requirements.
- I. Conceal pipe installations in walls, pipe spaces, or utility spaces; above ceilings; below grade or floors; and in floor channels unless indicated to be exposed to view.
- J. Prohibited Locations:
 - 1. Do not install fuel-oil piping in or through HVAC ducts and plenums, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - 2. Do not install fuel-oil piping in solid walls or partitions.
- K. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- L. Connect branch piping from top or side of horizontal piping.
- M. Install unions in pipes NPS 2 and smaller at final connection to each piece of equipment and elsewhere as indicated. Unions are not required on flanged devices.
- N. Do not use fuel-oil piping as grounding electrode.
- O. Install sleeves and sleeve seals for piping penetrations of walls, ceilings, and floors.
- P. Install escutcheons for piping penetrations of walls, ceilings, and floors of occupied spaces.

3.05 VALVE INSTALLATION

- A. Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
- B. Install valves in accessible locations.
- C. Install oil safety valves at inlet of each oil-fired appliance.
- D. Install pressure relief valves in distribution piping between the supply and return lines.
- E. Install one-piece, bronze ball valve with hose end connection at low points in fuel-oil piping.
- F. Install manual air vents at high points in fuel-oil piping.
- G. Install anti-siphon device where shown on drawings.

3.06 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Do not use Teflon tape.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- D. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to "Quality Assurance" Article.
 - 1. Bevel plain ends of steel pipe.
 - 2. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Flanged Joints: Install gasket material, size, type, and thickness for service application. Install gasket concentrically positioned.

3.07 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Install unions, in piping NPS 2-1/2 and smaller, adjacent to each valve and at final connection to each piece of equipment having threaded pipe connection.
- C. Install flanges, in piping NPS 3 and larger, adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
- D. Connect piping to equipment with shutoff valve and union. Install union between valve and equipment.
- E. Install flexible piping connectors at final connection to burners or oil-fired appliances.

3.08 LABELING AND IDENTIFYING

- A. Nameplates, pipe identification, valve tags, and signs are specified in "Identification for HVAC Piping and Equipment."

3.09 FIELD QUALITY CONTROL

- A. Pressure Test Piping: Minimum hydrostatic or pneumatic test-pressures measured at highest point in system:
 - 1. Fuel-Oil Distribution Piping: One and one-half times maximum working pressure with Minimum 5 psig for minimum 30 minutes.
 - 2. Suction Piping: Minimum 20-in. Hg for minimum 30 minutes.
 - 3. Isolate storage tanks if test pressure in piping will cause pressure in storage tanks to exceed 10 psig.
- B. Inspect and pressure/vacuum test fuel-oil piping according to NFPA 31, "Tests of Piping" Paragraph; and according to requirements of authorities having jurisdiction.
- C. Test leak-detection and monitoring system for accuracy by manually operating sensors and checking against alarm panel indication.
- D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Bleed air from fuel-oil piping using manual air vents.
- F. Fuel-oil piping and equipment will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.10 OUTDOOR PIPING SCHEDULE

- A. Aboveground fuel-oil piping shall be one of the following:
 - 1. NPS 2 and Smaller: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 and Larger: Steel pipe, steel welding fittings, and welded joints.
- B. Paint all exposed exterior fuel piping: (2) coats, primer and exterior grade topcoat. Color: White.

3.11 INDOOR PIPING SCHEDULE

- A. Aboveground fuel-oil piping shall be one of the following:
 - 1. NPS 5/8 to NPS 2: Steel pipe, steel or malleable-iron threaded fittings, and threaded joints.
 - 2. NPS 2-1/2 and Larger: Steel pipe, steel fittings, and welded or flanged joints.

END OF SECTION

SECTION 23 13 23
FACILITY ABOVEGROUND FUEL-OIL STORAGE TANKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Insulated, steel, fuel-oil ASTs.

1.03 DEFINITIONS

- A. AST: Aboveground storage tank.

1.04 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, and dimensions of individual components and profiles.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 3. Fuel-oil storage tank accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and ballast pads and anchors, and lifting or supporting points.
 - 2. Indicate dimensions, components, and location and size of each field connection.
 - 3. Shop Drawing Scale: 1/4 inch per foot minimum.

1.05 INFORMATIONAL SUBMITTALS

- A. Site Survey: Plans, drawn to scale, on which fuel-oil storage tanks are shown and coordinated with other services and utilities.
- B. Seismic Qualification Data: For ASTs, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.
- D. Sample Warranty: For special warranty.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-oil equipment and accessories to include in emergency, operation, and maintenance manuals.

1.07 QUALITY ASSURANCE

- A. EPA Compliance: Comply with EPA and state and local authorities having jurisdiction. Include recording of fuel-oil storage tanks and monitoring of tanks.

1.08 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-oil storage tanks that fail in materials or workmanship within specified warranty period.
 - 1. Storage Tanks:
 - a. Failures include, but are not limited to, the following when used for storage of fuel oil at temperatures not exceeding 150 deg F:
 - 1) Structural failures including cracking, breakup, and collapse.
 - 2) Corrosion failure including external and internal corrosion of steel tanks.
 - b. Warranty Period: 30 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 INSULATED, STEEL, FUEL-OIL AST

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ace Tank & Fueling Equipment, LLC.
 - 2. Greer Tank and Welding.
 - 3. Highland Tank & Manufacturing Company, Inc.
 - 4. Or approved equal.
- B. Description: UL 142 and UL 2085, thermally insulated and fire-resistant, double-wall, horizontal, steel tank; with primary- and secondary-containment walls and insulation and with interstitial space.
- C. Construction: Fabricated with welded, carbon steel and insulation; suitable for operation at atmospheric pressure and for storing fuel oil with specific gravity up to 1.1 and with test temperature according to UL 2085.

2.02 SHOP PAINTING OF AST

- A. Shop Cleaning: After fabrication, blast clean according to SSPC-SP 10/NACE No. 2.
- B. After cleaning, remove dust or residue from cleaned surfaces.
- C. If surface develops rust before prime coat is applied, repeat surface preparation.
- D. Apply manufacturer's standard prime coat to shop-cleaned, dry surface same day as surface preparation.
- E. Apply manufacturer's standard two-component, epoxy finish coats.

2.03 FUEL-OIL AST ACCESSORIES

- A. Tank Manholes: 22-inch-minimum diameter; bolted, flanged, and gasketed; centered on top of tank.
- B. Threaded pipe connection fittings on top of tank, for fill, supply, return, vent, sounding, and gaging. Include cast-iron plugs for shipping.
- C. Striker Plates: Inside tank, on bottom below fill, vent, sounding, gage, and other tube openings.
- D. Lifting Lugs: For handling and installation.
- E. Ladders: Carbon-steel ladder OSHA compliant outside tank, anchored to top and side wall. Comply with requirements in Section 05 50 00 - Metal Fabrications for exterior steel ladder.
- F. Supply Tube: Extension of supply piping fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.
- G. Sounding and Gage Tubes: Extension of fitting into tank, terminating 6 inches above tank bottom and cut at a 45-degree angle.

2.04 FUEL OIL DAY TANK (DT-1)

- A. Manufacturers: Simplex, ACE Tank, or equal.
- B. Provide all labor, material, equipment and supervision of labor for the complete installation of the fuel day tank of the size and configuration and with the accessories scheduled on the Drawings.
- C. The day tank shall be designed and supplied as an engineered system by the manufacturer. Each tank shall be of packaged design to include all inlet flow control devices, other valves, level controls, remote pump control, return pump, indicators, alarms and all other devices as required to form an integrated, functional system such that field installation is restricted largely to external piping, wiring and such intermediate devices that are required by code and/or good engineering practice to interconnect the bulk source of supply to the day tank, the day tank to the heating boiler and to provide for external vents as per local codes and UL-142, NFPA 31.
- D. Tank shall be all welded steel atmospheric tank of rectangular construction in accordance with UL 14 with taps for accessories and threaded connections. The tank shall be equipped with a welded steel channel base suitable for bolt attachment to a concrete pad.
- E. Accessories: Float switch, fuel level gauge, atmospheric vent, emergency vent, overflow, and inlet and outlet connections.
- F. Gauge: Remote reading, electronic, for two-wire, 24-volt power, with wall-mounted direct reading gauge.
- G. Installation shall be complete and in strict accordance with all local, State, and Federal codes, laws and regulations.
- H. The exterior of the Day Tank and the interior and exterior of the containment described below shall receive a heavy-duty industrial anticorrosion coating and be finish painted.
- I. The tank shall be installed and anchored within a steel containment basin having a minimum capacity of 150 percent of that of the Day Tank. The containment shall be protected against intrusion of debris. The containment shall be equipped with a leak detector that shall activate the "rupture" alarm described below.

- J. The Day Tank shall be equipped with a solenoid valve, 1-inch NPT, 100 psi, normally closed, under control of level controller described below. An inlet Shut-off valve shall be provided.
- K. Provide factory controller/indicator with functions to include adjustable differential pump/valve level control, tank level indication, system alarms and manual operating controls. Level controller shall be self-contained as a unit within a NEMA1 box mounted on top of the Day Tank. Factory controls shall include all relays, auxiliary contacts, level detectors and alarms as required to provide day tank status to the DDC system.

2.05 FUEL OIL TRANSFER PUMPS (PS-1)

- A. Manufacturers: Simplex, Ace Tank, or equal.
- B. Provide duplex packaged fuel oil pump set of the type, size and capacity scheduled on the Drawings. Pumps shall be positive displacement, direct drive units with non-overloading motors. Provide shaft-coupling guard.
- C. Pump units shall be mounted on a heavy gauge steel base and factory finished rated for 125 psi working pressure. Piping accessories shall include strainer, suction and discharge pressure gauges with gauge cocks, discharge pump check valve, integral discharge relief valves, strainer, and pump isolation valves. Provide other specialties as may be required or indicated on the drawings.
- D. Provide duplex controller, starters, main disconnect, H-0-A switches, all necessary controls, relays, auxiliary contacts, and pilot lights as required to meet the control sequence as specified in Section 23 09 93 - Sequence of Operations for Controls and interface with the day tank controls and building's HVAC DDC system.

2.06 LEAK-DETECTION AND MONITORING SYSTEM

- A. Cable and Sensor System: Comply with UL 1238.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Franklin Fueling Systems, TS-550 EVO.
 - b. OMNTEC Mfg Inc, OEL8000II.
 - c. Pneumercator Inc, TMS-2000.
 - 2. Calibrated leak-detection and monitoring system with probes and other sensors and remote alarm panel for fuel-oil storage tanks and fuel-oil piping.
 - 3. Include fittings and devices required for testing.
 - 4. Outputs: Dry Contact.
 - 5. Controls: Electrical, operating on 120-V ac.
 - 6. Calibrated liquid-level gage complying with UL listed floats, probes, or other sensors and remote annunciator panel.
 - 7. Remote Annunciator Panel: With visual and audible, high-tank-level and low-tank-level alarms; fuel indicator with registration in gallons; and overfill alarm. Include gage volume range that covers fuel-oil storage capacity.
 - 8. Outputs: 4-20ma analog output and dry contact.
 - 9. Controls: Electrical, operating on 120-V ac.

2.07 SOURCE QUALITY CONTROL

- A. Pressure test and inspect fuel-oil storage tanks, after fabrication and before shipment, according to ASME and the following:
 - 1. Horizontal, Insulated, Steel ASTs: UL 142 and UL 2085.
- B. Affix standards organization's code stamp.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine roughing-in for aboveground fuel-oil storage tanks to verify actual locations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 EARTHWORK

- A. Comply with requirements in Section 31 20 00 - Earth Moving for excavating, trenching, and backfilling.

3.03 FUEL-OIL AST INSTALLATION

- A. Install tank bases and supports.
- B. Connect piping and vent fittings.
- C. Install ground connections.
- D. Install tank leak-detection and monitoring devices.
- E. Install steel ASTs according to STI R912.
- F. Install insulated and concrete-vaulted, steel ASTs according to STI R942.
- G. Fill storage tanks with fuel oil.
- H. Storage tank shall be full at substantial completion.

3.04 LIQUID-LEVEL GAGE SYSTEM INSTALLATION

- A. Install liquid-level gage system. Install panel inside building where indicated.

3.05 LEAK-DETECTION AND MONITORING SYSTEM INSTALLATION

- A. Install leak-detection and monitoring system. Install alarm panel inside building.
 - 1. Double-Wall, Fuel-Oil Storage Tanks: Install probes in interstitial space.
 - 2. Single-Wall, Fuel-Oil Storage Tanks: Install probes as indicated.
 - 3. Install liquid-level gage.

3.06 LABELING AND IDENTIFYING

- A. Nameplates, pipe identification, and signs are specified in Section 23 05 53 - Identification for HVAC Piping and Equipment.

3.07 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Tanks: Minimum hydrostatic or compressed-air test pressures for fuel-oil storage tanks that have not been factory tested and do not bear the ASME code stamp or a listing mark acceptable to authorities having jurisdiction:
 - a. Single-Wall Tanks: Minimum 3 psig and maximum 5 psig.
 - b. Double-Wall Tanks:
 - 1) Inner Tanks: Minimum 3 psig and maximum 5 psig.
 - 2) Interstitial Space: Minimum 3 psig and maximum 5 psig, or 5.3-in. Hg vacuum.
 - c. Where vertical height of fill and vent pipes is such that the static head imposed on the bottom of the tank is greater than 10 psig, hydrostatically test the tank and fill and vent pipes to a pressure equal to the static head thus imposed.
 - d. Maintain the test pressure for one hour.
- B. ASTs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

**SECTION 23 21 13
HYDRONIC PIPING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes hydronic heating system, piping, fittings, glycol solution, controls, and accessories.

1.02 REFERENCES

- A. ASME B16.18 (American Society of Mechanical Engineers) - Cast Copper Alloy Solder Joint Pressure Fittings.
- B. ASME B16.22 (American Society of Mechanical Engineers) - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- C. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.
- D. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- E. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- F. ASTM B16.3 – Malleable Iron Threaded Fittings.
- G. ASTM B32 - Solder Metal.
- H. ASTM B88 - Seamless Copper Water Tube.
- I. AWS (American Welding Society) D1.1 - Structural Welding Code – Steel.

1.03 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, provide compatible system components and joints. Provide flanges, union, and couplings at locations requiring servicing.
- B. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems. Do not use direct welded or threaded connections to valves, equipment, or other apparatus.
- C. Provide pipe hangers and supports in accordance with Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- D. Use ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Use globe valves for throttling, bypass, or manual flow control services.
- F. Use check valves on discharge of pumps.
- G. Use globe valves for throttling service.
- H. Use butterfly valves in heating water systems interchangeably with gate valves.

- I. Use 3/4-inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.04 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit data on pipe materials, pipe fittings, valves, and accessories. Submit manufacturers catalog information. Indicate valve data and ratings.
- C. Test Reports: Submit piping pressure test reports.

1.05 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 73 00 – Execution Requirements and Section 22 00 00 – General Mechanical Provisions.
- B. Operation and Maintenance Data: Submit product data, instructions for installation and changing components, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems.
- B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum three years documented experience.
- B. Fabricator or Installer: Company specializing in performing Work of this Section with minimum three years documented experience.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 60 00 - Material and Equipment.
- B. Accept valves on-site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- E. Dehydrate and charge refrigeration components including piping and receivers, seal prior to shipment. Maintain seal until connected into system.

1.09 ENVIRONMENTAL REQUIREMENTS

- A. See approved Storm Water Pollution Prevention Plan (SWPPP) and Section 31 20 00 - Earth Moving.
- B. Do not install underground piping when bedding is wet or frozen.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 HEATING WATER AND GLYCOL PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40, black.
 - 1. Fittings: ASTM B16.3, malleable iron or grooved ductile iron conforming to ASTM A536, Grade 65-45-12.
 - 2. Joints: Threaded, welded, or grooved couplings with ductile iron housing conforming to ASTM A536, Grade 65-45-12, and EPDM gasket of central cavity of pressure- responsive design provide with nuts and bolts to secure housing halves.
- B. Copper Tubing: ASTM B88, Type L hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, ASME B16.22 solder wrought copper, or ASTM B75 C12200 wrought copper grooved.
 - 2. Joints: Solder, lead-free, ASTM B32, 95-5 tin-antimony, or any IAPMO approved lead-free solder. Grooved couplings with ductile iron housing conforming to ASTM A536, Grade 65-45-12, and EPDM gasket of central cavity of pressure- responsive design provide with nuts and bolts to secure housing halves

2.02 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53, Schedule 40 galvanized.
 - 1. Fittings: Galvanized cast iron, or ASTM B16.3 malleable iron.
 - 2. Joints: Threaded or grooved mechanical couplings.
- B. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or any IAPMO approved lead-free solder.

2.03 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 Inches and under:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe over 2 Inches:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16-inch-thick preformed neoprene.
- C. Dielectric Connections: Epco Sales, Inc., Cleveland, Ohio, or equal. Select gasket materials for compatibility with fluid used, temperature, and pressure.
 - 1. Flanges, 2-1/2 Inches and Larger: 150-pound ASME Standard, with bolt insulators, dielectric gasket, bolts, and nuts.

2.04 FLEXIBLE CONNECTORS

- A. Manufacturers: K-Flex, Metraflex, or equal.
- B. Seamless, stainless steel, close pitch convolutions, reinforced with braided stainless steel or bronze wire cover. Rated not less than 125 psi at 350 deg F to be furnished at inlets and outlets of all equipment. Sizes and connections to match piping and equipment.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

- A. Install glycol piping in accordance with ASME B31.9.
- B. Route piping parallel to building structure and maintain gradient.
- C. Install piping to conserve building space, and not interfere with use of space.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipe passing through partitions, walls and floors.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- H. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with other Work.
- I. Slope piping and arrange systems to drain at low points.
- J. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- K. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 91 23 – Interior Painting.
- L. Install valves with stems upright or horizontal, not inverted.

- M. Insulate piping and equipment. Refer to Section 23 07 00 - HVAC Insulation

3.03 EXPANSION LOOPS, GUIDES

- A. See Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
- B. Calculate expansion from minus 20 deg F to maximum operation temperature of system.
- C. Provide guides to properly direct pipe movement into expansion loops and offsets.
- D. Provide anchors of an approved design to control movement in piping. Weld anchors to ferrous piping and braze anchors to nonferrous piping.
- E. Install in accordance with standards of Expansion Joint Manufacturer's Association.

3.04 FIELD QUALITY CONTROL

- A. See Section 01 45 00 - Quality Control.

3.05 START-UP / DEMONSTRATION

- A. See Section 01 79 00 – Demonstration and Training and Section 22 00 00 – General Mechanical Provisions.
- B. Provide at least two hours of operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of the hydronic heating piping system. The demonstration shall include, but not be limited to the following:
 - 1. Proper support and vibration isolation of all equipment and piping.
 - 2. Proper operation of all valves and specialties.
 - 3. Proper operation of entire hydronic heating system.

END OF SECTION

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**SECTION 23 21 16
HYDRONIC PIPING SPECIALTIES**

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pressure gauges.
2. Pressure gauge taps.
3. Thermometers.
4. Thermometer supports.
5. Test plugs.
6. Flexible connectors.
7. Expansion tanks.
8. Diaphragm-type expansion tanks.
9. Air vents.
10. Hydraulic separators.
11. Strainers.
12. Pump suction fittings.
13. Combination pump discharge valves.
14. Flow controls.
15. Relief valves.
16. Glycol charging equipment.
17. Glycol solution.

1.02 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

C. Underwriters Laboratories Inc.:

1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.03 PERFORMANCE REQUIREMENTS

- A. Flexible Connectors: Provide at or near pumps and motorized equipment where piping configuration does not absorb vibration.

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

- B. Product Data: Submit for manufactured products and assemblies used in this Project.
 - 1. Manufacturer's data indicating use, operating range, total range, accuracy, and location for manufactured components.
 - 2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
 - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
 - 4. Submit electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.

1.05 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for calibrating instruments, maintenance schedule instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.
- C. Submit results of glycol strength tests.

1.06 ENVIRONMENTAL REQUIREMENTS

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

1.07 MAINTENANCE SERVICE

- A. Section 01 73 00 - Execution Requirements: Maintenance service.
- B. Furnish service and maintenance of glycol fluid and glycol charging components for

PART 2 - PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers: Trerice, Weksler, or approved equal.
- B. Gauge: ASME B40.1, with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background.
 - 1. Case: Cast aluminum or stainless steel.
 - 2. Bourdon Tube: Brass or Type 316 stainless steel.
 - 3. Dial Size: 3-1/2-inch diameter.
 - 4. Mid-Scale Accuracy: One percent.
 - 5. Scale: Psi.

2.02 STEM TYPE THERMOMETERS

- A. Manufacturers: Trerice, Weksler, or approved equal.

- B. Thermometer: ASTM E1, adjustable angle, red-appearing mercury, 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 glass or Lexan.
 - 3. Stem: Brass, 3/4-inch NPT, 3-1/2 inches long.
 - 4. Accuracy: 2 percent.
 - 5. Calibration: Degrees F.

2.03 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions.
- B. Flange: 3-inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.04 TEST PLUGS

- A. Test Taps: Manufactured by, Richardson, Texas, or equal. Manufacturers: Fittings shall be Peterson Engineering Company, Pete's Plug Griswold or approved equal.
- B. Combination pressure and temperature test taps consisting of a 1/4-inch MPT fitting and cap designed to receive either a 1/8-inch outside diameter temperature or pressure probe, at inlet and outlet water connections of all heat transfer equipment and at other locations as shown.
 - 1. Neoprene core for temperatures up to 200 deg F.
 - 2. Nordel core for temperatures up to 350 deg F.

2.05 DIAPHRAGM-TYPE EXPANSION TANKS (ET-1)

- A. Manufacturers: Amtrol, Taco, or approved equal.
- B. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psig, and 350 deg F maximum water operating temperature with flexible butyl diaphragm sealed into tank.
- C. Accessories: Tank shall be a pre-charged, horizontal diaphragm type for ceiling mounting, size as shown, with air-charging fitting, and all other required tapings and with factory prime coat.

2.06 AIR VENTS

- A. Manufacturers: Hoffman, Taco, or approved equal.
- B. Provide air vents at elbows where flow is diverted downward, at system high points, unit ventilators, cabinet unit heaters, coils, and where shown on the Drawings. Provide air vents with isolation gate valves. Air vents shall be designed for use on hot or cold lines. Maximum hydrostatic pressure 200 psi. Hoffman No. 79 or equal.
- C. Where space available is insufficient for above specified installation, such as within baseboard enclosure, use Taco Series 426 or equal with isolation cock.

2.07 AIR SEPARATORS

- A. In-Line Air/Dirt Separators:
 - 1. Basis of Design: Spirovent, Taco, Bell & Gossett.

2. Tank: Welded steel tank. ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
3. System Connections: Threaded for 2-inch and smaller; flanged connections for 2-1/2-inch and larger.
4. Coalescence: Permanently affixed, dual wound, continuous copper core tube or 304 stainless steel pall rings.
5. Performance:
 - a. Air Removal: 100 percent of free air, 100 percent of entrained air, and up to 99.6 percent of dissolved air.
 - b. Dirt Removal: 80 percent of 30-micron particles within 30 passes.
6. Blowdown Connection: Threaded connection for removal of sediment.
7. Air Removal Connection: Threaded connection for air vent.

2.08 STRAINERS

- A. Manufacturers: Watts, Amtrol, or approved equal.
- B. Size 2 Inches and Under: Screwed brass or iron body for 175 psig working pressure, Y pattern with 1/32-inch stainless steel perforated screen.
- C. Size 2-1/2 Inches to 4 Inches: Flanged iron body for 175 psig working pressure, Y pattern with 3/64-inch stainless steel perforated screen.

2.09 GLYCOL MIXING TANK (GMT-1)

- A. Manufacturer: Skidmore S-55-100-2-PEFS, Axiom SF100, or approved equal.
- B. Provide a complete packaged automatic hydronic make-up system. System shall include 55-gallon storage/mixing tank with cover; pump suction hose with inlet strainer; pressure pump with thermal cut-out; integral pressure switch; integral check valve; cord and plug.
- C. Provide low pressure alarm package.

2.10 HEATING GLYCOL SOLUTION

- A. Manufacturers: Dow Chemical Dowfrost, Dynalene PG or approved equal.
- B. Shall be a factory pre-mixed solution of corrosion inhibited propylene glycol and water mixed 50 percent glycol / 50 percent water, suitable for operating temperatures from minus 34 deg F to 250 deg F.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: K-Flex, Metraflex or equal.
- B. Seamless, stainless steel, close pitch convolutions, reinforced with braided stainless steel or bronze wire cover. Rated not less than 125 psi at 350 deg F to be furnished at inlets and outlets of all equipment. Sizes and connections to match piping and equipment.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install all specialties in accordance with manufacturer's installation recommendations.

3.02 INSTALLATION - THERMOMETERS AND GAGES

- A. Install one pressure gage for each pump, locate on suction and discharge of pump; provide isolation valve on taps and pipe to gage.
- B. Install gage taps in piping.
- C. Install pressure gages with pulsation dampers. Provide needle valve or ball valve to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.03 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Locate test plugs where indicated.
- B. Where large air quantities accumulate, provide enlarged air collection standpipes.
- C. Provide isolation valves on all air vents.
- 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 and connect to expansion tank.
- G. Provide drain and hose connection with valve on strainer blow down connection.
- H. Support pump fittings with floor mounted pipe and flange supports.
- I. Provide isolation valves on water inlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.
- J. Provide balancing valves on water outlet for the following terminal heating unit types: radiation, unit heaters, and fan coil units.

- K. Provide relief valves on heat exchangers.
- 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. Route glycol system discharges to glycol storage tank.
- 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 12 psig. Pressure system cold at 5 psig.

3.04 INSTALLATION HYDRONIC SPECIALTY EQUIPMENT

- A. Support tanks from building structure. Provide seismic restraint.

3.05 FIELD QUALITY CONTROL

- A. Sections 01 60 00 - Material and Equipment and 01 73 00 - Execution Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test for strength of glycol and water solution and submit written test results.

3.06 GLYCOL AND HYDRONIC SYSTEM WATER TREATMENT

- A. Prior to the completion and startup of the boiler and hydronic system, the CONTRACTOR shall obtain and deliver to an independent testing laboratory, a sample of the permanent water supply from which the hydronic system will be filled.
- B. CONTRACTOR shall obtain from the laboratory a written water analysis and written documentation of the type of chemical treatment to be applied and the recommended period of retesting and chemical reapplication.
- C. CONTRACTOR shall submit a copy of the laboratory analysis and recommendations to the DEPARTMENT for review. Upon approval, the CONTRACTOR shall perform the system start-up providing the recommended treatment.
- D. A copy of the treatment, retest schedule, and reapplication schedule shall be included in the maintenance manuals.

3.07 CLEANING

- A. Section 01 73 00 - Execution Requirements: Requirements for cleaning.
- B. Clean and flush glycol system before adding glycol solution.

3.08 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 73 00 - Execution Requirements: Requirements for protecting installed construction.
- B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION

**SECTION 23 21 23
HYDRONIC PUMPS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. System lubricated circulators.
 - 2. In-line circulators.

1.02 REFERENCES

- A. National Electrical Manufacturers Association:
 - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. Underwriters Laboratories Inc.:
 - 1. UL 778 - Motor Operated Water Pumps.

1.03 PERFORMANCE REQUIREMENTS

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

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.05 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 CLOSE COUPLED END SUCTION PUMP (CP-1A, CP-1B):

- A. Manufacturers: Grundfos, Taco, Bell & Gossett, or approved equal.
- B. Type: Horizontal shaft, single stage, close coupled, with resiliently mounted motor, for 175 psi maximum working pressure.

- C. Casing: Cast iron, with flanged pump connections.
- D. Impeller: Cast Iron.
- E. Bearings: Heavy duty sealed ball bearings.
- F. Shaft: Alloy or stainless steel with stainless steel or bronze sleeve.
- G. Seal: Ceramic/ EPT mechanical seal. Seals shall be for use with glycol fluid.
- H. Drive: Provided with pump, programmed for self-sensing operation.

2.02 SMALL WET-ROTOR PUMPS

- A. Basis of Design: Bell & Gossett, Taco, Armstrong, Grundfos
- B. Description: Factory-assembled and -tested, wet-rotor pump.
- C. Pump Construction:
 - 1. Body: Cast iron.
 - 2. Impeller: Composite, Noryl, or Stainless Steel.
 - 3. Pump Shaft: Ceramic.
 - 4. Bearings. Double-sintered carbon.
- D. Motor: Multi-Speed.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install Work in accordance with State of Alaska standards and local code amendments.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- C. Provide line-sized shut-off valve and line-sized soft seat check valve and balancing valve on pump discharge.
- D. Provide air cock and drain connection on horizontal pump casings.
- E. Provide drains for bases and seals.
- F. Lubricate pumps before start-up.

3.02 FIELD QUALITY CONTROL

- A. See Sections 01 45 00 - Quality Control, 01 73 00 - Execution Requirements, and 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.03 START-UP / DEMONSTRATION

- A. See Section 01 79 00 – Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.
- B. Provide at least 4 hours of operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of all hydronic pumps. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation of all hydronic pumps.
 - 2. Proper operation of all valves and specialties.

END OF SECTION

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**SECTION 23 31 13
METAL DUCTS**

PART 1 - GENERAL

1.01 SUMMARY

- A. The work of this section consists of furnishing and installing ductwork, intakes, discharges, and appurtenances in connection with heating, and ventilation. Section includes metal ductwork, casing and plenums, and duct cleaning.

1.02 REFERENCES

- A. ASTM A36 - Structural Steel.
- B. ASTM A90 - Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles.
- C. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. NFPA 90A (National Fire Protection Association) - Installation of Air Conditioning and Ventilating Systems.
- E. NFPA 90B (National Fire Protection Association) - Installation of Warm Air Heating and Air Conditioning Systems.
- F. SMACNA (Sheet Metal Air Conditioning Contractors' National Association) - HVAC Air Duct Leakage Test Manual.
- G. SMACNA (Sheet Metal Air Conditioning Contractors' National Association) - HVAC Duct Construction Standards - Metal and Flexible.
- H. UL 181 (Underwriters Laboratories, Inc.) - Factory-Made Air Ducts and Connectors.

1.03 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.04 SUBMITTALS

- A. Submit under the provisions of Sections 01 33 00 and 22 00 00.
- B. Shop Drawings: Submit detailed shop drawings for all ductwork. Indicate duct fittings, ductwork accessories, gauges, sizes, welds, and configuration for all duct systems.
- C. Product Data: Submit data for duct materials, duct liner, and duct connectors.

1.05 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Sections 01 70 10 and 22 00 00.

- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.07 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturer.
- B. Maintain temperatures during and after installation of duct sealant.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 DUCT MATERIALS

- A. Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G60 zinc coating in conformance with ASTM A90.
- B. Fasteners: Rivets, bolts, or sheet metal screws.
- C. Hanger Rod: ASTM A36; steel; threaded both ends, threaded one end, or continuously threaded.

2.02 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings. Furnish duct material, with gauges, bracing, reinforcement, construction details, and sealing for operating pressures indicated and in accordance with the latest edition of the ASHRAE Handbook, ANSI/NFPA 90A, and SMACNA Guides.
- B. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
- C. Diagonally or transversely, cross-break all panels on ducts.
- D. Duct dimensions indicated on Drawings are net, inside, clear dimensions. For internally lined ducts, add lining thickness to determine metal duct dimensions.

- E. Duct metal gauge thickness shall be in accordance with the SMACNA HVAC Duct Construction Standards requirements for low velocity systems.
- F. Plenums shall be 16-gauge-galvanized sheet metal reinforced with galvanized steel angle frames, with angles at 30 inches on center. Provide access doors and reinforce around doors with galvanized sheet angle.
- G. Low pressure, rectangular duct joints to be flush, driven slip, for exposed ducts and where otherwise required for reasons of space limitations; otherwise standing seams.
- H. Elbows:
 - 1. Construct radius elbows with inside radius not less than duct width.
 - 2. Use miter elbows, unless indicated otherwise, at following locations: exposed elbows; immediately upstream from supply air outlets; where required to facilitate installation.
 - 3. Round elbows shall have full throat radius wherever possible.
- I. Alter duct sizes on basis of equal friction where required to facilitate installation.
- J. At air outlets, paint visible portions of duct interior flat black.
- K. At exposed duct penetrations of walls, floors, and ceilings, provide sheet metal angle type escutcheons.
- L. Branch takeoffs shall be radiused tap-in type or straight tap-in with extractor, unless otherwise noted.
- M. Round Ducts:
 - 1. Round ducts shall be in accordance with Duct Construction Standards, latest edition, as published by SMACNA.
 - 2. Round ducting shall be spiral seam type only. Transverse Joints shall be beaded sleeve joint or companion flange joint. Branch takeoffs shall be 45-degree TEE type, or conical 90-degree TEE type as detailed on the Drawings.
- N. Transitions: Provide tapered transitions at changes in duct size and at connections to fans and other equipment. Offset not more than 20 degrees on diverging flow and 30 degrees on converging flow, unless otherwise shown on the Drawings.
- O. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Minimum 4-inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- P. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

2.03 DUCT HANGERS AND SUPPORTS

- A. Hangers and supports shall be in accordance with Duct Construction Standards, latest edition, as published by SMACNA.
- B. Supports from steel beams and similar construction shall be from appropriate beam clamps.
- C. Rectangular Duct Supports:
 - 1. Through 24 inches: 1-inch by 16 gauge straps fastened to ductwork and structure, maximum 10-foot spacing. Maximum strap length 5 feet. For support in excess of 5 feet in length use steel rods with trapeze angles.

2. Through 42 inches: Steel rods fastened to ductwork angle stiffeners or trapeze angle, maximum 8-foot spacing.
 3. Over 42 inches: Steel rods fastened to ductwork angle stiffeners or trapeze angle, maximum 4-foot spacing.
- D. Round Ducts:
1. Through 24 inches: 1-inch by 16 gauge strap bolted to 26 gauge duct band, maximum 10-foot spacing. Maximum strap length 5 feet for supports in excess of 5 feet in length use steel rods with 8 gauge bands.
 2. Through 42 inches: Steel rod bolted to 8-gauge duct band, maximum 8 feet spacing.
 3. All exposed round ducts shall be secured with steel rods regardless of size.
- E. Wall Supports: Welded steel brackets for all sizes.
- F. Floor Supports:
1. Steel pipe or angle iron pedestal with welded floor flange bolted to floor.
 2. Support duct from pedestals with angle steel trapeze cradle or fasten to duct angle stiffeners.

2.04 FLASHING

- A. Ducts through roof shall be 16 gauge, stainless steel, flashed and counter flashed, and provided with storm collars to secure watertight construction.

2.05 BIRD AND INSECT SCREENS

- A. Stainless steel, 1-inch mesh, 0.063-inch diameter, set in galvanized steel frame. Extend frame so airflow is not restricted.

2.06 INSULATION

- A. Insulated ducts shall be as specified in Section 23 07 00 - HVAC Insulation.

2.07 FLEXIBLE DUCTWORK

- A. UL 181, Class 1, Air Duct material complying with NFPA 90A and 90B.
- B. Factory fabricated assembly composed of a black CPE Liner permanently bonded to a corrosion resistant helically wound spring steel wire; supporting a 1-inch thick fiberglass insulation blanket; 0.10 perm fiberglass reinforced metalized film laminate vapor barrier with integral brass hanger grommets.
- C. Pressure Rating: 6-inch wg. positive and 1-inch wg. negative.
- D. Maximum Velocity: 1000 FPM.
- E. Manufacturer: Thermaflex M-KE, Atcoflex UPC #039, or equal.

2.08 PLENUMS AND CASINGS

- A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.

- B. Mount floor mounted casings on 4-inch high concrete curbs. At floor, rivet panels on 8-inch centers to angles. Where floors are acoustically insulated, furnish liner of 18 gauge galvanized expanded metal mesh supported at 12-inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce access doorframes with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- D. Fabricate acoustic casings with reinforcing turned inward. Furnish 16 gauge back facing and 22-gauge perforated front facing with 3/32-inch diameter holes on 5/32-inch centers. Construct panels 3 inches thick packed with 4.5 lb./cu ft minimum glass fiber media, on inverted channels of 16 gauge.

2.09 CLOTHES DRYER EXHAUST DUCTING

- A. Manufactures: Nordfab Quick-Fit or Equal
- B. Premanufactured clamp together 22 gauge ducting system.
- C. Galvanized steel ducting laser welded with rolled lip.
- D. Galvanized steel duct clamps with over center spring lever action.
- E. Silicon sealing o-rings.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify sizes of equipment connections before fabricating transitions.

3.02 INSTALLATION

- A. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- B. Except as otherwise specified or shown, all ductwork shall be constructed in accordance with SMACNA HVAC Duct Construction Standards.
- C. All duct seams shall be adequately constructed and sealed to minimize air leakage. Maximum total system acceptable leakage shall correspond to SMACNA HVAC Air Duct Leakage Test Manual, Seal Class A, Leakage Class 6. Seal all joints with Hardcast sealing systems or equal. All ductwork shall be sealed to withstand testing for air tightness.
- D. Work shall be designed and fabricated to prevent buckling, breathing, vibration, and noise. Provide any additional reinforcing as may be required to meet the actual job conditions.
- E. Work shall be designed and fabricated to keep resistance losses to a minimum. Where short radius elbows are necessary, provide splitters concentric with the elbow radii.
- F. Ductwork shall be adequately supported by rods, trapeze hangers or 16 gauge steel bands, as required by the 1995 SMACNA HVAC Duct Construction Standards and as approved by the DEPARTMENT
- G. Duct penetrations through walls with high sound transmission loss or vibration isolated ducts passing through walls shall have space between duct and wall packed with multiple layers of high-density sponge neoprene rod to reduce transmission of sound.

- H. Provide special duct hangers as detailed on the Drawings.
- I. Use double nuts and lock washers on threaded rod supports.
- J. All duct appurtenances shall be accessible through duct access panels. Provide additional building access panels to ductwork where required for easy access to mechanical appurtenances. Submit tabulated, itemized listing of all proposed building access panels. Include location, size, function, proposed finish, and type.
- K. Hydronic piping specialties shall be accessible through air handling equipment access panels. Where common access cannot be provided, provide additional duct and building access panels.
- L. Construct wall penetrations per NFPA 90A. Seal all openings around ductwork through walls, floors, etc., with suitable non-combustible material per NFPA 90A.
- M. Provide duct escutcheons where ducts pass through walls, floors, and ceilings exposed to view to present a neat and finished appearance. Submit shop drawings for approval.
- N. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.
- O. Coordinate duct location with the work of other Sections.

3.03 FLEXIBLE DUCTWORK

- A. Position insulated flexible ductwork to diffuser or duct branch with duct tape. Install nylon duct strap "zip strip" over duct and collar then tension strap as required to provide positive attachment of the duct to the metal collar. Trim excess strap from connection. All flexible ductwork branches shall be limited to 5 feet maximum length.

3.04 INTERFACE WITH OTHER PRODUCTS

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
- B. Connect diffusers or light troffer boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
- C. Connect terminal units to supply ducts with 1-foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.05 CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient airflow, clean one-half of system completely before proceeding to other half. Protect equipment with potential to be harmed by excessive dirt with temporary filters, or bypass during cleaning.

3.06 SCHEDULES

DUCTWORK PRESSURE CLASS SCHEDULE

AIR SYSTEM	PRESSURE CLASS
Supply	4-inch wg
Return and Relief	1-inch wg
General Exhaust	2-inch wg

END OF SECTION

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SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Back-draft dampers.
 - 2. Duct access doors.
 - 3. Dynamic fire dampers.
 - 4. Static fire dampers.
 - 5. Volume control dampers.
 - 6. Flexible duct connections.
 - 7. Duct test holes.
 - 8. Dial thermometers.
 - 9. Static pressure gages.

1.02 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. ASTM International:
 - 1. ASTM E1 - Standard Specification for ASTM Thermometers.
- C. National Fire Protection Association:
 - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
 - 2. NFPA 92A - Recommended Practice for Smoke-Control Systems.
- D. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- E. Underwriters Laboratories Inc.:
 - 1. UL 555 - Standard for Safety for Fire Dampers.
 - 2. UL 555C - Standard for Safety for Ceiling Dampers.
 - 3. UL 555S - Standard for Safety for Smoke Dampers.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data for shop fabricated assemblies and hardware used.
- C. Product Data: For fire dampers, smoke dampers, and combination fire and smoke dampers submit the following:
 - 1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
 - 2. Indicate materials, construction, dimensions, and installation details.

3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
 4. Type of actuators and electrical characteristics if appropriate.
- D. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 CLOSE-OUT DOCUMENTS

- A. Product Data: Provide as-built information of submittal requirements.
- B. Maintenance: Provide operation and maintenance manuals for equipment noting model number, part numbers, and regular maintenance schedules.

1.05 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 FILTERS

- A. Filter Box: Section with filter guides, access doors from both sides, for side loading with gaskets and blank-off plates.
- B. Media: UL 900 listed; shall consist of a lofted, high performance, non-woven, reinforced cotton and synthetic fabric. Provide 2-inch thick media.
1. The filter media shall have an average efficiency of 25 to 30 percent on ASHRAE Test Standard (52-76). It shall have an average arrestance of not less than 90 to 92 percent on that standard. Filters shall be listed by Underwriters' Laboratories as Class 2. Manufacturer: Farr 30/30 or equal.
 2. Filter Gauges: 3-1/2-inch-diameter diaphragm-actuated dial in metal case with static pressure tips. Manufacturer: Dwyer 2000 photohelic gauges.

2.02 BACK-DRAFT DAMPERS

- A. Manufacturers: Ruskin, Greenheck, or equal.
- B. Gravity Backdraft Dampers, Size 18 by 18 inches or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
- C. Multi-Blade, Back-Draft Dampers: Parallel-action, gravity-balanced, galvanized 16 gauge thick steel, or extruded aluminum. Blades, maximum 6-inch width, center pivoted, with felt or flexible vinyl sealed edges. Blades linked together in rattle-free manner with 90-degree stop, steel ball bearings, and plated steel pivot pin. Furnish dampers with adjustment device to permit setting for varying differential static pressure.

2.03 FIRE DAMPERS

- A. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream or curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - 1. Minimum Thickness: per manufacturer's listing and of length to suit application.
 - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.04 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Single Blade Dampers: Fabricate for duct sizes up to 6- by 30-inch.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8- by 72-inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches w.g.
- E. Quadrants:
 - 1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
 - 2. On insulated ducts, mount quadrant regulators on standoff mounting brackets, bases, or adapters.
 - 3. Where rod lengths exceed 30 inches furnish regulator at both ends.

2.05 INSULATED POSITIVE SHUT-OFF CONTROL DAMPERS

- A. Manufacturer: T. A. Morrison, TAMCO 9000, Greenheck ICD-44, or equal.
- B. Extruded aluminum (6063T5) damper frame shall be not less than 0.080-inch in thickness. Damper frame to be 4 inches deep and shall be insulated with polystyrene on three sides if "Installed in Duct" type and on four sides if "Flanged to Duct" type.
- C. Blades shall be extruded aluminum (6063TS) profiles, internally insulated with non-CFC, expanded polyurethane foam, and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55.

- D. Blade and frame seals shall be of extruded silicone and shall be secured in an integral slot within the aluminum extrusions.
- E. Bearings to be comprised of a celcon inner bearing fixed to a 7/16-inch aluminum hexagon blade pin rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal, or metal-to-plastic contact.
- F. Linkage hardware shall be installed in frame side, shall be constructed of aluminum and corrosion resistant, zinc, and nickel-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- G. Dampers shall be opposed blade action. Dampers shall be made to size required without blanking off of free area. Dampers shall be available in two mounting types: "Installed in Duct" or "Flanged to Duct." Dampers to be designed for operation in temperatures ranging between minus 40 deg F and 212 deg F.
- H. Air leakage through a 48- by 48-inch damper shall not exceed 4.12 cfm/sq. ft. against 4 inches w.g. differential static pressure at standard air. Standard air leakage data to be certified under the AMCA Certified Ratings Program. Air leakage shall not exceed 4.9 cfm/sq. ft. against 4 inches w.g. differential static pressure at minus 40 deg F.
- I. Pressure drop of a fully open 48- by 48-inch damper shall not exceed 0.03-inch w.g. at 1,000 fpm. Installation of dampers shall be in accordance with manufacturer's installation guidelines.

2.06 ACCESS DOORS

- A. Reach-through doors shall be located at fire dampers, inlet side of coils, and where required to service internal duct appurtenances. Doors shall be stiffened to prevent rattle or vibration and shall be secured airtight with felt-edged gaskets. Secure the hinge and sash lock. Access doors to be insulated where adjacent duct is insulated or lined. Access doors shall be suitably sized for intended duty. See Article 3.02, Installation, for sizes.
- B. Manufacturers: Ruskin ADH, Greenheck HAD, or equal.
- C. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- D. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1-inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches square, secure with sash locks.
 - 2. Up to 18 inches square: Furnish two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches.
 - 4. Larger Sizes: Furnish additional hinge.
 - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.07 TURNING VANES

- A. In all 90-degree turns in ducts where radius elbows with a centerline radius equal to 1-1/2 times the duct width are not used. Turning vanes shall be constructed as per 1995 SMACNA HVAC Duct Construction Standards.
- B. Provide single width turning vanes for lengths less than 30 inches. Single-wide turning vanes shall be 2-inch radius on 1-1/2-inch centers and shall be single thickness.

- C. Provide double width turning vanes for all applications with turning vanes lengths 30 inches long and over. Double width turning vanes shall be 4-1/2-inch inner radius with 2-1/4-inch outer radius on 3-1/4-inch centers.

2.08 FLEXIBLE DUCT CONNECTIONS

- A. Flexible duct connections shall be installed at the inlet and discharge connections of air handling units and fans and as shown on Drawings.
- B. Round flexible duct connections shall be of a two-element spiral construction composed of a corrosion-resistant metal supporting spiral and a coated fabric with a mineral base. Flexible duct connectors shall be listed by UL, Class 1 ducts, and shall have a flame spread rating not exceeding 25 and a smoke developed rating not exceeding 50. Fuel contributed rating not exceeding 50.
- C. Square flexible duct connections shall be UL listed, fire-retardant, neoprene coated, woven glass fiber fabric, in accordance with NFPA 90A, minimum density 30 oz/sq. ft. and crimped into 3-inch wide and 24 gauge thick galvanized steel collars. Install per SMACNA HVAC Duct Construction Standards.
- D. Flexible duct connection shall be suitable for 1-1/2 times the duct pressure at the connection. Flexible separation shall not be less than 6 inches between separated metals.

2.09 DIAL THERMOMETERS

- A. Manufacturers: Trerice, Weksler, or equal.
- B. Thermometer: ASTM E1, stainless steel case, adjustable angle with front calibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
 - 1. Size: 3-inch diameter dial.
 - 2. Lens: Clear glass or Lexan.
 - 3. Accuracy: 1 percent.
 - 4. Calibration: Degrees F.

2.10 STATIC PRESSURE GAUGES

- A. Manufacturers: Dwyer, Ashcroft, or equal.
- B. Dial Gauges: 3-1/2-inch diameter dial in metal case, diaphragm actuated, black figures on white background, front calibration adjustment, 2 percent of full-scale accuracy.
- C. Inclined Manometer: Plastic with red liquid on white background with black figures, front calibration adjustment, 3 percent of full-scale accuracy.
- D. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4-inch diameter copper tubing.

2.11 DUCT TEST HOLES

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

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify rated walls are ready for fire damper installation.
- B. Verify ducts and equipment installations are ready for accessories.

3.02 INSTALLATION

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 13 - Metal Ducts for duct construction and pressure class.
- B. Install back-draft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated on Drawings.
- C. Install turning vanes in square or rectangular 90-degree elbows in supply and exhaust air systems, and elsewhere as shown. Where turning vanes are installed at an angle other than 45 degrees, vanes shall be fabricated with side parallel to adjacent ducts to ensure parallel airflow.
- D. Install duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and as indicated on Drawings.
 - 1. Install to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
 - 2. Locate to provide easy access to dampers, controls, valves, other operating equipment, and to the linkage and catch of fire dampers.
 - 3. Install minimum 8- by 8-inch size for hand access, 18- by 18-inch size for shoulder access, and as indicated on Drawings. Install 4- by 4-inch for balancing dampers only. Review locations prior to fabrication.
- E. Install duct test holes as required for testing and balancing purposes.
- F. Provide duct thermometers across (before and after) each heating and cooling coil.
- G. Provide fire dampers and combination fire and smoke dampers at locations as indicated on Drawings. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings, and hinges.
- H. Install combination smoke and fire dampers in accordance with NFPA 92A.

3.03 FIELD QUALITY CONTROL

- A. Operate installed duct accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required, to obtain proper operation and leak-proof performance.

3.04 START-UP/DEMONSTRATION

- A. See Section 01 79 00 - Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.

- B. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT, the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
1. Proper operation and installation of each air distribution system, controls, and all associated appurtenances.
 2. Maintenance access to all components and filters.
 3. Demonstrate re-setting of fire dampers to DEPARTMENT.

END OF SECTION

SECTION 23 34 00
HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Ventilation fans.
 - 2. Exhaust fans.
 - 3. Ceiling fans.

1.02 REFERENCES

- A. American Bearing Manufacturers Association:
 - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
 - 1. AMCA 99 - Standards Handbook.
 - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
 - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
 - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
 - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- C. American Refrigeration Institute:
 - 1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
- D. National Electrical Manufacturers Association:
 - 1. NEMA MG 1 - Motors and Generators.
 - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. Underwriters Laboratories Inc.:
 - 1. UL 705 - Power Ventilators.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.

1.04 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 EXHAUST FAN (EF-1 THROUGH 8)

- A. Manufacturer: Greenheck, Loren Cook, or approved equal.
- B. Type: Direct drive centrifugal fan with inline intake and off set discharge.
- C. Construction: Galvanized steel housing, backward inclined aluminum wheel, with integral access panels, connections and guards.
- D. Motor: ECM with 0-10V controls input.
- E. Accessories: Provide with toggle switch, two speed controller, motor thermal overload, motor cover, inlet guard, and greased bearings.

2.02 VENTILATION FAN (VF-1)

- A. Manufacturer: Greenheck, Loren Cook, or approved equal.
- B. Type: Direct drive centrifugal fan with inline intake and discharge.
- C. Construction: Galvanized steel housing with MERV 8 filter box, aluminum wheel, with integral access panels, connections and guards.
- D. Motor: ECM with 0-10V controls input.
- E. Accessories: Provide with toggle switch, temperature based speed control, motor thermal overload, motor cover, inlet guard, and greased bearings.

2.03 CEILING PROPELLER FANS (CF-1 THROUGH 5)

- A. Manufacturers: Greenheck, Big Ass Fans, or equal.
- B. Ceiling fans to be high volume low speed and shall bear the AMCA certified ratings seal.
- C. All motors to be high efficiency direct-drive, totally enclosed, and factory mounted and wired variable frequency drive.
- D. All fans to have factory-installed Secondary Support Cable Assembly connected to the fan assembly.
- E. Fan blades to be straight extruded aluminum airfoils with winglets for maximum efficiency.
- F. Controller: Keypad speed controller.

2.04 EXHAUST FAN (EF-9)

- A. Manufacturer: Greenheck, Nederman, or approved equal.
- B. Type: Belt-drive fan wheel blower with side intake and top discharge.
- C. Construction: Continuously welded steel housing, with integral access panels, connections, and guards.
- D. Motor: VFD rated Nema premium efficiency motor.

- E. Accessories: Motor and belt cover, inlet guard, and greased bearings.
- F. Controls: Provide with VFD capable of interfacing with building DDC System.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment in accordance with the recommendations of the manufacturer and as required by NFPA 70 and NFPA 91 as applicable.
- B. Install fan units in locations shown on the Drawings.
- C. When fans are ducted, install with flexible connections as specified in Section 23 33 00 - Air Duct Accessories.

3.02 ADJUSTMENT

- A. Speed adjustment of V-belt drive fans, when required to produce specified capacity, may be done with adjustable sheaves for a single V-belt or by replacing sheaves for a multiple V-belt. See Section 22 05 00 - Basic Mechanical Materials and Methods.
- B. Test and balance fans for required airflow as specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.03 START-UP/DEMONSTRATION:

- A. See Section 01 79 00 - Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of all systems. The demonstration shall include, but not be limited to, the following:
 - 1. Proper operation and installation of each exhaust fan, controls, and all associated appurtenances.
 - 2. Maintenance access to all components.

END OF SECTION

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**SECTION 23 34 50
MAKE-UP AIR UNITS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Packaged make up air unit.

1.02 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
 - 2. ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.
 - 3. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

1.03 SUBMITTALS

- A. Product Data: Submit data indicating:
 - 1. Cooling and heating capacities.
 - 2. Dimensions.
 - 3. Weights.
 - 4. Rough-in connections and connection requirements.
 - 5. Duct connections.
 - 6. Electrical requirements with electrical characteristics and connection requirements.
 - 7. Controls.
 - 8. Accessories.
 - 9. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.

1.04 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of controls installed remotely from units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.05 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years' experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept units on site. Inspect for damage.
- B. Protect units from damage by storing off roof until roof mounting curbs are in place.

1.07 COORDINATION

- A. Coordinate installation of roof curbs with roof structure, roof deck and roof membrane installation.

1.08 WARRANTY

- A. Division 01 - Product warranties and product bonds.

1.09 EXTRA MATERIALS

- A. Furnish one set of filters and fan belts for each unit.

PART 2 - PRODUCTS

2.01 MAKE-UP AIR UNITS (MAU-1)

- A. Manufacturer: Daikin, Trane, or approved equal.
- B. Type: Unit with integral heating shall be fully assembled at the factory and consist of an insulated metal cabinet, a seismic curb assembly, a motorized intake damper, supply air blower assembly, air filter, and electrical control unit with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.
- C. Cabinet: Double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - 1. Outside Casing: G90 galvanized steel with 6-inch formed channel base rail.
 - 2. Internal Casing: galvanized steel
 - 3. Insulation: R-13 injected foam insulation.
- D. Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - 1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it shall also meet the Fire Hazard Classification shown below.
 - 2. Minimum Thickness: 1 inch (25 mm).
 - 3. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - 4. Location and Application: Floor of each unit shall be insulated with minimum 1-inch-thick rigid fiberglass insulation, covered on one surface with integral aluminum foil.
 - 5. Supply Air Blower Assembly: Blower assembly consists of an electric motor and a belt driven, double width, double inlet forward curve blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on minimum 1.125-inch-thick neoprene vibration isolators.
- E. Blower: Direct drive plenum fan with ECM motor. Fan and motor shall have a minimum turn down of 30 percent. Speed shall be controlled via 0-10 volt signal from DDC.
- F. Filters: Unit shall be provided with 2-inch-thick MERV 8 disposable filters.
- G. Coils: Heat coils shall be provided integral to the unit.

- H. Air dampers: Low leakage insulated dampers shall be provided on unit inlet.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify housekeeping pads are installed and dimensions are as shown on shop drawings.

3.02 INSTALLATION

- A. Install units on vibration isolators. Connect units to supply and return ductwork with flexible connections.
- B. Install components furnished loose for field mounting.
- C. Install electrical devices furnished loose for field mounting.
- D. Install control wiring between unit and field installed accessories.
- E. Install all equipment in accordance with the recommendations of the manufacturer and as required by NFPA 70 as applicable.
- F. Install fan units in locations shown on the Drawings.
- G. Provide duct connections, installed with flexible connections as specified in Section 23 33 00 - Air Duct Accessories.

3.03 FAN ADJUSTMENT

- A. Test and balance fans for required airflow as specified in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.04 CLEANING

- A. Vacuum clean coils and inside of unit cabinet.
- B. Install new throwaway filters in units at Substantial Completion.

3.05 SPARE PARTS

- A. Provide (3) complete sets of replacement MERV8 filters.

3.06 START-UP/DEMONSTRATION

- A. See Section 01 79 00 - Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of all systems. The demonstration shall include, but not be limited to, the following:
 - 1. Proper operation and installation of each exhaust fan, controls, and all associated appurtenances.

2. Maintenance access to all components.

END OF SECTION

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

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Diffusers.
 - 2. Registers.
 - 3. Grilles.
 - 4. Louvers.
 - 5. Hoods.

1.02 REFERENCES

- A. Air Movement and Control Association International, Inc.:
 - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
 - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Color and finish chart as noted in Products section.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 73 00 - Execution Requirements and Section 22 00 00 - General Mechanical Provisions.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

PART 2 - PRODUCTS

2.01 CEILING SUPPLY DIFFUSERS (SD-1 & 2)

- A. Manufacturers: Price SCD, Titus TMS, or equal.
- B. Type: Square Cone Diffuser.
- C. Frame: Compatible with lay-in panel.

- D. Fabrication: Steel with baked enamel off-white finish.
- E. Accessories: Provide with lay-in panel.

2.02 CEILING SUPPLY DIFFUSERS (SD-3)

- A. Manufacturers: Price PDF, Titus PAS, or equal.
- B. Type: Perforated Ceiling Diffuser.
- C. Frame: Drop in.
- D. Fabrication: Steel with baked enamel off-white finish.

2.03 CEILING EXHAUST GRILLES (RG-1)

- A. Manufacturers: Price 80, Titus 50F, or equal.
- B. Type: Egg Crate Grille.
- C. Frame: Compatible with lay-in panel.
- D. Fabrication: Steel with baked enamel off-white finish.

2.04 DRUM LOUVER (SG-1 THRU 7)

- A. Manufacturers: Price HCD, Titus S-DL, or equal.
- B. Type: Duct Mounted Supply Grille.
- C. Frame: Curve frame for duct mounting.
- D. Fabrication: Steel with baked enamel off-white finish.

2.05 VEHICLE EXHAUST HOSE REEL (EHR-1 &2)

- A. Manufacturers: Nederman, Monoxivent, or equal.
- B. Type: Motorized Hose reel.
- C. Controls: Handheld IR remote, limit switches, and automatic fan control.
- D. Nozzles: Galvanized steel stack adaptor, clamping tailpipe nozzle.

2.06 LOUVERS

- A. Manufacturers: Greenheck, Ruskin, or equal.
- B. Product Description: Stationary Drainable.
- C. Type: 6 inch deep with blades on 45 degree slope, heavy channel frame.
- D. Fabrication: 0.081 inch thick extruded aluminum, welded assembly, with factory baked enamel finish color to be selected by ARCHITECT.

- E. Mounting: Furnish with screw holes in jambs for installation.
- F. Bird Screen: Bird screen with 1/2 inch square mesh for exhaust and 3/4 inch for intake.
- G. Insect Screen: Aluminum mesh, set in aluminum frame.

2.07 WEATHER HOODS

- A. Fabricate weather hoods in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible.
- B. Fabricate of reinforced stainless steel, minimum 18 gauge. Furnish bird screen with 1-inch square mesh.
- C. Seal exterior wall penetration weather tight.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify inlet/outlet locations.
- B. Verify ceiling and wall systems are ready for installation.

3.02 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 91 23 - Interior Painting.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.04 START-UP/DEMONSTRATION

- A. See Section 01 79 00 - Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.
- B. CONTRACTOR shall demonstrate, to the satisfaction of the DEPARTMENT, the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation and installation of all diffusers, registers, grilles and all associated appurtenances.
 - 2. Air delivery to each room at desired flow and within desired sound power levels.
 - 3. Prior to air balancing, replace all filters.

END OF SECTION

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SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes manufactured double-wall chimneys for fuel-fired equipment.

1.02 REFERENCES

- A. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- B. ASTM A924 - General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- C. ASTM A653 - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- D. ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent) Hot-Rolled Commercial Quality.
- E. NFPA 31 - Standard for the Installation of Oil-Burning Equipment.
- F. NFPA 54 – National Fuel Gas Code.
- G. NFPA 211 (National Fire Protection Association) - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- H. SMACNA (Sheet Metal and Air Conditioning Contractors National Association) - HVAC Duct Construction Standards - Metal and Flexible.
- I. UL 103 (Underwriters Laboratories, Inc.) - Standard for Factory Built Low Heat Chimneys.
- J. UL 378 (Underwriters Laboratories, Inc.) - Standard for Draft Equipment.
- K. UL 641 (Underwriters Laboratories, Inc.) - Standard for Low Temperature Venting Systems.
- L. SMACNA (Sheet Metal and Air Conditioning Contractors National Association) - Guide for Steel Stack Construction.

1.03 DEFINITIONS

- A. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- B. Vent: Portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- C. Connector: Part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent and may include a draft control device.

1.04 DESIGN REQUIREMENTS

- A. Factory built vents and chimneys used for venting positive pressure appliances complying with NFPA 211 and UL listed and labeled.

1.05 SUBMITTALS

- A. Submit under the provisions of Division 01 and Section 22 00 00 - General Mechanical Provisions.
- B. Shop Drawings: Submit detailed factory shop drawings of the entire venting system for each fuel-fired appliance or each combined assembly. Shop drawing shall include all fittings, supports and guides, expansion joints, venting and all apparatus for a complete installation. Indicate general construction, dimensions, weights, supports, and layout of venting. Submit fasteners to be used for connection to supporting structure. Submit layout drawings indicating plan view and elevations.
- C. Product Data: Submit data indicating factory-built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics, UL listings, and connection requirements.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
- E. Submit complete detailed factory computer performance analysis and sizing calculations of the entire flue gas venting system for each appliance and/or each combined assembly.

1.06 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 73 00 – Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.
- B. Submit operation and maintenance data for the entire flue gas venting system; product data, installation instructions, and joint connection details.

1.07 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Maintain water integrity of roof during and after installation of chimney or vent.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 DOUBLE WALL METAL STACKS

- A. Manufacturers: Selkirk IPS, Van Packer DW, or approved equal.
- B. Furnish double wall metal stacks, tested to UL 103 and UL listed, for use with building heating equipment, in compliance with NFPA 211.
- C. Fabricate with 1 inch minimum air space between walls. Construct inner jacket of 20 gageType 304 or Type 316 stainless steel. Construct outer jacket of Type 304 or Type 316 stainless steel 24 gage.

- D. Accessories, UL labeled:
1. Insulated Roof Thimble: Consists of roof penetration, vent flashing with spacers, insulation and storm collar.
 2. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.
 3. Firestop: Firestop for penetration of combustible floors, walls, or ceilings.
 4. Drip Leg with Cleanout Cap: 12-inch-long, stainless steel tee with drain outlet.
 5. Appliance Adapter: Joint locking strap with tabs for connection to appliance.
 6. Roof flashing.
 7. Adjustable Pipe Lengths: Compensates for thermal expansion and contraction between two fixed points on low pressure applications. Consists of pipe plus inner slip section, two-piece outer jacket, and insulation to match typical pipe sections.
 8. Elbow Fittings: As required for pipe direction change for structure, double-walled construction.
 9. Wall and Roof Support Assemblies: Used to support the weight of the pipe, steel construction including brackets, struts, and associated hardware, designed to resist both gravity and lateral seismic loads. Install per pipe manufacturer's recommendations with appropriate fasteners.
 10. Ceiling finish ring.
 11. Furnish adjustable self-actuating barometric draft dampers at full size of vent where recommended by manufacturer's installation guidelines.
 12. Provide with factory fabricated ports as needed for blocked vent switch and sensors as required.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify location of structure and clearance from combustibles. Provide offsets as required.

3.02 INSTALLATION

- A. Install in accordance with the International Mechanical Code and NFPA 31.
- B. Install materials in accordance with the equipment manufacturer's installation guidelines, the stack manufacturer's guidelines and all associated listings.
- C. Factory manufactured components shall be installed in accordance with manufacturer's recommendations.
- D. Flue stack diameters shall be sized per the manufacturer's computerized calculations. Minimum size shall be as shown on the Contract Drawings.
- E. Support stack from building structure rigidly with suitable ties, braces, hangers, and anchors to hold to shape and prevent buckling. Support chimneys and stacks at 12-foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size. Supports from ceiling structure shall be secured to multiple joists to distribute load, submit proposed support method and fasteners for review and approval prior to installation.
- F. Maintain clearances from combustibles.
- G. Stacks and chimneys shall not be less than the size of the connector appliance outlet, unless otherwise indicated on the drawings.
- H. Provide drain tee fitting and cap at the base of each vertical stack riser.
- I. Coordinate installation of dampers, and draft hoods as recommended by the manufacturer.

- J. Flue stacks and chimneys shall be terminated a minimum of 3 feet above the roof, with a minimum 2-foot clearance above any portion of the roof within 10 feet of the stack and a minimum of 3 feet clearance above any forced air inlet within 10 feet of the stack cap.
- K. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.
- L. Factory stacks shall be braced and reinforced with rigid guys suitable for 130 mph winds, Exposure Category D, and applicable seismic loads. Provide seismic control per the IBC Seismic Site Class Definition of the project site.
- M. Level and plumb chimney and stacks.
- N. Clean venting, chimneys, and stacks during installation, removing dust and debris.
- O. Install slip joints allowing removal of appliances without removal or dismantling of venting, venting insulation, chimneys, or stacks.
- P. Install factory manufactured stack assemblies with expansion compensation sections as recommended by the manufacturer.
- Q. Pitch venting with positive slope up from fuel-fired equipment to chimney or stack.
- R. Install vent dampers, locating close to draft hood collar, and secured to venting.
- S. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement to ASTM C105. Connect base section to foundation using anchor lugs.
- T. Level and plumb chimney and stacks.
- U. Clean venting, chimneys, and stacks during installation, removing dust and debris.
- V. Install slip joints allowing removal of appliances without removal or dismantling of venting, venting insulation, chimneys, or stacks.

END OF SECTION

**SECTION 23 52 23
CAST-IRON BOILERS**

PART 1 - GENERAL

1.01 SUMMARY

- A. The work of this Section consists of furnishing and installing fuel fired hot water boilers included but not limited to cast-iron boilers, controls, boiler trim, fuel connections and flue stack connections.

1.02 REFERENCES

- A. ASME Section I (American Society of Mechanical Engineers) - Boiler and Pressure Vessel Code - Rules for Construction of Power Boilers.
- B. ASME Section VIII, Division 1, (American Society of Mechanical Engineers) - Boiler and Pressure Vessel Code - Rules for Construction of Pressure Vessels.
- C. ASME Section IV (American Society of Mechanical Engineers) - Boiler and Pressure Vessel Code - Rules for Construction of Heating Boilers.
- D. HI (Hydronics Institute) - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.
- E. NFPA 31 (National Fire Protection Association) – Standard for the Installation of Oil-Burning Equipment.

1.03 SUBMITTALS

- A. Submit under the provisions of Division 01 and Section 22 00 00 - General Mechanical Provisions.
- B. Product Data: Submit data indicating manufacturer, model number, capacities and accessories included with boiler. Include general layout, dimensions, size and location of water, fuel, electric and vent connections, electrical characteristics, weight and mounting loads.
- C. Test Reports: Section torquing report. Indicate boilers meet or exceed specified performance and efficiency. Submit results of combustion test.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- E. Tool Certification: Torque wrench calibration certificate.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 73 00 - Execution Requirements and Section 22 00 00 - General Mechanical Provisions.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.
- C. Manufacturer's Field Start-Up Reports: Indicate condition of equipment after start-up including combustion test, control settings and performance chart of control system.

1.05 QUALITY CONTROL

- A. Conform to ASME Section IV and UL 726 for construction of boilers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.
- B. Conform to applicable code for internal wiring of factory wired equipment.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

1.06 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Accept boilers and accessories on site in factory shipping packaging. Inspect for damage.
- B. Protect boilers from damage by leaving packing in place until installation.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 CAST-IRON BOILERS (B-1A/B)

- A. Manufacturers: De Dietrich, Burnham, or equal.
- B. Furnish and install fuel oil fired, boiler of size, type and capacity as indicated on the Drawings, complete with all accessories, in accordance with manufacturer's instructions and in compliance with the rules and regulations of authorities having jurisdiction.
- C. Identification: Data shall be clearly cast or stamped on the front of the boiler or on a manufacturer's standard nameplate that has been permanently attached to the boiler front. Show name and address of manufacturer, trade name, model number, series number, date of manufacture, and capacity.
- D. Boiler Fabrication:
 - 1. Assembly: Cast iron sections with 30 psig water ASME Boilers and Pressure Vessels Code rating, assembled with push nipples or gaskets and draw rods.
 - 2. Furnish access for flue passages for cleaning and flame observation ports.
 - 3. Structural Base: Aluminized steel lined with high temperature mineral fiber insulating panels.
 - 4. Jacket: Glass fiber insulated steel jacket, finished with factory applied baked enamel.
- E. Hot Water Boiler Trim:
 - 1. ASME rated pressure relief valve, 30 psig.
 - 2. Combination water pressure and temperature gage. Furnish graduated pressure gage scale from 1-1/2 to 3 times pressure relief valve pressure setting.

3. Low water cut-off to prevent burner operation when boiler water falls below safe level (float-type).
 4. Electronic Operating Temperature Controller:
 - a. NEMA 250 Type 1 enclosure with full cover for wall mounting.
 - b. Ambient temperature range minus 50 deg F to plus 150 deg F.
 - c. Adjustable reset ratio of outside air temperature change to discharge control point change 1:2 to 100:1.
 - d. Integral set point adjustment 80 deg F to 230 deg F.
 - e. Electronic primary and outdoor sensors.
 - f. Suitable for on-off switching of pilot duty single-throw double-pole relays.
 5. High limit temperature controller with manual reset for burner to prevent boiler water temperature from exceeding safe system temperature.
 6. Redundant high limit temperature controller with manual reset for burner. Strap unit to supply discharge pipe and fasten probe tight to pipe.
 7. Rollout thermal fuse element.
 8. Spill switch.
 9. Boiler air vent.
 10. Vertical draft hood with automatic vent damper.
 11. Control transformer.
 12. Drain valve.
 13. Circulator relay.
 14. Combination high and low limit control.
 15. Boiler Fuel Burning System: Provide, furnish, and install ETL or UL approved fuel burning system including factory installed burner control panel in accordance with the requirements of the state and local codes. The complete fuel burning system shall further be in full accordance with UL Listing.
- F. Burner:
1. Burner Safety Controls: Energize burner motor and electric ignition, limit time for establishment of main flame, monitor flame continuously during burner operation and stop burner on flame failure with manual reset necessary.
 2. Controls: Pre-wired, factory assembled electronic controls in control cabinet with flame scanner or detector, programming control, relays, and switches. Furnish pre-purge and post-purge ignition and shutdown of burner in event of ignition pilot and main flame failure with manual reset.
 3. Blocked Vent Switch: Pressure or heat sensing switch capable of disabling boiler burner with manual reset.
- G. Boiler Performance: Rate performance in accordance with HI - Testing and Rating Standard for Cast Iron and Steel Heating Boilers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install equipment in accordance with the International Mechanical Code, NFPA 31, and NFPA 30.
- B. Assemble boiler from knockdown configuration after transporting into boiler room. Notify Owner of when assembly and section torquing will occur.
- C. Perform pressure test on boiler after assembly in accordance with the following:
 1. Pressure test before connecting fuel piping, electrical connections, and controls.

2. Install boiler drain and pressure gauge.
 3. Plug remaining openings.
 4. Fill boiler with hydronic solution and vent air.
 5. Pressure test to 1-1/2 times working pressure for water boilers for 10 minutes with no leaks.
 6. Repair leaks and retest.
 7. After successful test, drain and remove plugs from openings to be used for piping connections and controls.
- D. Provide Manual Emergency Shutdown Switch: Locate near boiler room exit doors and mount 60 inches AFF. Wire switch through the burner controls. Provide with a red switch plate marked "Emergency Boiler Shutdown" and the boiler number.
- E. Install boilers plumb and level, to plus or minus 1/16 inch over boiler base.
- F. Maintain manufacturer's recommended clearances around and over boilers.
- G. Install boiler on concrete housekeeping pad. Refer to Section 03 30 00 - Cast-in-Place Concrete.
- H. Connect fuel oil piping in accordance with the International Mechanical Code.
- I. Connect fuel oil piping to boiler; arrange piping with clearances for burner removal and service.
- J. Connect hot water piping to supply and return boiler connections.
- K. Install discharge piping from relief valve, discharge to glycol tank
- L. Install boiler trim and accessories furnished loose for field mounting.
- M. Install electrical devices furnished loose for field mounting.
- N. Install control wiring between boiler control panel and field mounted control devices.
- O. Provide and install stack and draft regulators in accordance with manufacturer's recommendations and Section 23 51 00 - Breechings, Chimneys, and Stacks.

3.02 FIELD QUALITY CONTROL

- A. Perform combustion test including boiler firing rate, over fire draft, fuel flow rate, heat input, burner fuel pressure, percent carbon monoxide, percent oxygen, percent excess air, flue gas temperature at outlet, ambient temperature, net stack temperature, percent stack loss, percent combustion efficiency, and heat output. Perform test at minimum, mid-range, and high fire.
- B. Arrange with local authorities having jurisdiction for inspection of boiler and piping and for certificate of operation.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Start-up boilers according to manufacturer's start-up instructions and in presence of DEPARTMENT's Representative. Test controls and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.

3.04 CLEANING

- A. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

3.05 START-UP / DEMONSTRATION

- A. As specified in Division 01 and Section 22 00 00 - General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the boiler equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT's Representative the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation and installation of boilers, burners, controls, safety devices and all associated appurtenances.
 - 2. All manufacturer's recommended maintenance access and clearances from combustibles have been maintained.

END OF SECTION

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SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes heat recovery ventilators, motors, drives, and accessories.

1.02 REFERENCES

- A. AMCA 99 (Air Movement and Control Association) - Standards Handbook.
- B. AMCA 210 (Air Movement and Control Association) - Laboratory Methods of Testing Fans for Rating.
- C. AMCA 300 (Air Movement and Control Association) - Reverberant Room Method for Sound Testing of Fans.
- D. AMCA 301 (Air Movement and Control Association) - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- E. ASHRAE 84 (American Society of Heating, Refrigerating, and Air Conditioning Engineers) - Method of Testing Air-to-Air Heat Exchangers
- F. NFPA 70 (National Fire Protection Association) – National Electric Code.
- G. NFPA 91 (National Fire Protection Association) - Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.
- H. SMACNA (Sheet Metal Air Conditioning Contractors' National Association) - HVAC Duct Construction Standards - Metal and Flexible.
- I. UL 507 (Underwriter's Laboratory) – Electric Fans.
- J. UL 705 (Underwriters Laboratories, Inc.) - Power Ventilators.

1.03 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00 – Submittal Procedures and Section 22 00 00 – General Mechanical Provisions.
- B. Shop Drawings: Indicate size and configuration of heat recovery ventilator assembly, mountings, weights, ductwork, and accessory connections.
- C. Product Data: Submit data on fans and accessories including fan curves with specified operating point plotted, power, RPM, sound power levels for both inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.

1.04 CLOSEOUT SUBMITTALS

- A. Submit operations and maintenance data under provisions of Section 01 73 00 – Execution Requirements and Section 22 00 00 – General Mechanical Provisions.
- B. Operation and Maintenance Data: Submit product data, instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 QUALIFICATIONS

- A. Manufacturer: 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 three years documented experience.

1.06 QUALITY ASSURANCE

- A. Fans shall be tested in accordance with procedures of AMCA 210 and shall meet the requirements of AMCA standards where applicable standards exist.
- B. Fans shall bear the UL label and the AMCA Certified Rating Seal when the fan is covered by the standard. When no standard is applicable, the manufacturer shall submit data to verify the fan capacity at the specified conditions. Where Sone ratings are shown, the manufacturer shall certify that the fan has been tested in accordance with AMCA 300 and that the Sone level does not exceed that shown.
- C. ASHRAE Compliance: Capacity ratings for energy recovery devices shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors, shafts, and bearings from weather and construction dust.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units until ductwork is clean, filters in place, bearings lubricated, and unit has been test-run under observation.

1.09 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 PACKAGED ENERGY RECOVERY UNITS (HRV-1)

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified:
 - 1. Fantech.
 - 2. Approved equal.
- B. Housing: Insulated 20 gauge powder coated galvanized steel cabinet, gasketed and caulked weathertight. Insulation to be foil faced fiberglass duct liner. Knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.
- C. Heat Recovery Device: Fixed-plate aluminum heat recovery core. Plates shall be sealed to ensure no cross-contamination of airstreams.
- D. Filters: Four washable electrostatic panel type air filters.
- E. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.
- F. Blowers: Two, factory-balanced motors with backward curved blades, one located in each air stream. Motors come with permanently lubricated sealed ball bearings.

- G. Defrost Cycle: Defrost mode automatically activated by unit controls when supply air is less than 23 deg F. Features an automatic timed supply fan shutdown.
- H. Hoods: Weatherproof hood, with gravity backdraft damper and birdscreen for exhaust and birdscreen for supply. See Section 23 37 00 - Air Outlets and Inlets for construction.
- I. Support: Suspend unit from trusses with four threaded rods connected to two "U" channel members running the length of the unit. Provide vibration isolators at interface between channel and rod.
- J. Drain: Two 1/2-inch outside diameter drain spouts provided, entire bottom of unit covered by pan.
- K. Controls: Remote control with touch screen input with VOC and RH sensor and adjustment of the ventilation rate.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install, wire, and balance unit in accordance with manufacturer's instructions.
- B. Support suspended units from structure in accordance with manufacturer's installation instructions.
- C. Install units with clearances for service and maintenance.
- D. Install controls in accordance with manufacturer's instructions.
- E. Clean filters at completion of equipment installation and before testing, adjusting, and balancing.

3.02 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ductwork, fittings, and specialties.
- B. Provide flexible duct connectors at all duct connections to unit.
- C. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- E. Provide wiring for all control devices.

3.03 TRAINING

- A. Provide training to DEPARTMENT personnel in accordance with Section 01 79 00 - Demonstration and Training on operation and maintenance of unit including, but not limited to, filter locations and servicing requirements, controls, usage of booster and dehumidistat switches (if applicable), programming of controls (if applicable), and defrost cycle operation and expected frequency of operation during winter.
- B. Automatic Self-Test: Show DEPARTMENT personnel the automatic self test sequence that will occur on the unit when it is turned on before normal operation begins.
- C. Provide training on the importance of leaving unit on whenever the building is occupied including code requirement of fresh air, mold management, and odor mitigation.

3.04 SPARE PARTS

- A. Provide (3) complete sets of replacement MERV8 filters.

3.05 START-UP/DEMONSTRATION:

- A. See Division 01 and Section 22 00 00 – General Mechanical Provisions.
- B. Provide operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. The CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT the complete and proper operation of all systems. The demonstration shall include, but not be limited to, the following:
 - 1. Proper operation and installation of unit, controls, and all associated appurtenances.
 - 2. Maintenance access to all components.

END OF SECTION

SECTION 23 82 00
CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Air coils.
 - 2. Finned tube radiation.
 - 3. Unit heaters.
 - 4. Cabinet unit heaters.
 - 5. Hydronic radiant heaters.

1.02 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
 - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
- B. Sheet Metal and Air Conditioning Contractors:
 - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate 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.
- C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.01 GLYCOL HEATING COILS

- A. Casing with access to both sides of coils. Enclose coils with headers and return bends exposed outside casing. Slide coils into casing through removable end panel.
- B. Drain Pans: Place 24-inch pans downstream of coil and down spouts for cooling coil banks more than one coil high.

- C. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410.
- D. Fabrication:
 - 1. Tubes: 5/8-inch OD seamless copper expanded into fins, brazed joints.
 - 2. Fins: Aluminum.
 - 3. Casing: Die formed channel frame of galvanized steel.
- E. Water Heating Coils:
 - 1. Headers: Cast iron with tubes expanded into header, seamless copper tube with silver brazed joints, or prime coated steel pipe with brazed joints.
 - 2. Configuration: Self-draining circuitry, with threaded plugs for drain and vent and threaded plugs in return bends and in headers opposite each tube; serpentine type with return bends on smaller sizes and return headers on larger sizes.
- F. Leak Testing: Air test under water to 200 psig for working pressure of 200 psig and 220 deg F.

2.02 UNIT HEATERS (UH-1 THROUGH 13)

- A. Manufacturers: Rittling, Vulcan, or equal.
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Casing: 0.0478-inch-thick steel with threaded pipe connections for hanger rods.
- D. Finish: Factory applied baked enamel of color as selected.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on projection models and four-way louvers on horizontal throw models.
- G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.

2.03 ELECTRIC UNIT HEATERS (EUH-1)

- A. Manufacturers: King, Trane, or equal.
- B. Assembly: UL listed and labeled assembly with terminal box and cover, and controls.
- C. Heating Elements: Exposed helical coil of nickel-chrome resistance wire with refractory ceramic support bushings.
- D. Cabinet: 20 Gauge steel with easily removed front panel with integral air outlet and inlet grilles.
- E. Fan: Direct-drive propeller type, statically and dynamically balanced, with fan guard.
- F. Motor: Permanently lubricated, sleeve bearings for horizontal models; ball bearings for vertical models.
- G. Control: Two-stage operation, factory provided low voltage thermostat. Furnish thermal overload.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify wall construction and ductwork is ready for installation.
- B. Verify concealed blocking and supports are in place and connections are correctly located.

3.02 INSTALLATION

- A. Install coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal, and Flexible.
- B. Support coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Install coils level.
- E. Make connections to coils with unions and flanges.
- F. Locate water supply at bottom of supply header and return water connection at top. Install manual air vents at high points complete with stop valve.
- G. Install water coils to be drainable and install drain connection at low points.
- H. On water and glycol heating coils, connect water supply piping to leaving airside of coil (counter flow arrangement).
- I. Insulate headers located outside airflow as specified for piping. Refer to Section 23 07 00 - HVAC Insulation.
- J. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.
- K. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- L. Cabinet Unit Heaters: Install at locations as indicated on Drawings. Coordinate to assure correct recess size for recessed units.

3.03 CLEANING

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

3.04 START-UP/DEMONSTRATION

- A. See Section 01 79 00 - Demonstration and Training and Section 22 00 00 - General Mechanical Provisions.
- B. Provide at least one hour of operating and maintenance instructions for maintenance personnel responsible for operating the equipment.
- C. CONTRACTOR shall demonstrate to the satisfaction of the DEPARTMENT, the complete and proper operation of all systems. The demonstration shall include, but not be limited to the following:
 - 1. Proper operation of all hydronic terminal units associated appurtenances.

END OF SECTION

SECTION 23 83 16
RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes radiant-heating piping, including the following:
 - 1. PEX pipe and fittings.
 - 2. Distribution manifolds.
 - 3. Piping specialties.

1.02 BUY AMERICAN PREFERENCE

- A. This project must meet Federal-Aid (FAA) Buy American Preference requirements for "Total Facility." Reference Specification Section 00750 Part III and Section 00800 SC-6.5. The intent is for the Bidder to comply with 100% Buy American Preferences of 49 USC 50101(a). Items not meeting 100% Buy American requirements shall be identified during the bid process to allow the Bidder to prepare a Type 3 or Type 4 Waiver request prior to Contract award.

1.03 SUBMITTALS

- A. Buy American Compliance: All submittals shall include a certification or other evidence that products meet Buy American Preference requirements of the project. This may include evidence that the product was submitted in an approved Type 3 or Type 4 waiver request prior to contract award. Submittals without the certification or other evidence indicating compliance will be rejected without further review.

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
- B. Delegated Design: Contractor shall engage design services to develop radiant tubing layout for each radiant zone as shown on the drawings capable of meeting the scheduled performance in the contract drawings.
- C. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

PART 2 - PRODUCTS

2.01 PEX PIPE AND FITTINGS

- A. Manufacturers:
 - 1. MrPex Systems Inc.

2. Uponor.
 3. Or approved equal.
- B. Pipe Material: PEX plastic according to ASTM F876.
- C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Fittings: ASTM F1960, cold expansion fittings and reinforcing rings.
- E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.02 DISTRIBUTION MANIFOLDS

- A. Manufacturers:
1. Uponor.
 2. MrPex Systems Inc.
 3. Or approved equal.
- B. Manifold: Minimum NPS 1, stainless steel.
- C. Main Shutoff Valves:
1. Factory installed on supply and return connections.
 2. Two-piece body.
 3. Body: Brass or bronze.
 4. Ball: Chrome-plated bronze.
 5. Seals: PTFE.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 225 deg F.
- D. Manual Air Vents:
1. Body: Bronze.
 2. Internal Parts: Nonferrous.
 3. Operator: Key furnished with valve, or screwdriver bit.
 4. Inlet Connection: NPS 1/2.
 5. Discharge Connection: NPS 1/8.
 6. CWP Rating: 150 psig.
 7. Maximum Operating Temperature: 225 deg F.
- E. Balancing Valves:
1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
 2. Ball or Plug: Brass or stainless steel.
 3. Globe Cartridge and Washer: Brass with EPDM composition washer.
 4. Seat: PTFE.
 5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
 6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
 7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
 8. CWP Rating: Minimum 125 psig.
 9. Maximum Operating Temperature: 250 deg F.

F. Zone Control Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

G. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

H. Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.

2.03 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 deg F to plus 185 deg F.

B. Floor Mounting Staples:

1. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
2. Minimum Thickness: 3/32 inch.
3. Width: Minimum, wider than tubing.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Install the following types of radiant-heating piping for the applications described:

1. Piping in Exterior Pavement: PEX.
2. Piping in Interior Reinforced-Concrete Floors: PEX.

3.02 INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems, pumps, and radiant manifolds. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Balance loop

- lengths for each manifold to ensure the longest loop is no more than 110 percent of the length of the shortest loop.
- B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
 - C. Connect radiant piping to manifold in a reverse-return arrangement.
 - D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
 - E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Section 08 31 13 - Access Doors and Frames.
 - F. See Section 23 21 13 - Hydronic Piping and Section 23 21 16 - Hydronic Piping Specialties for pipes and connections to hydronic systems and for glycol-solution fill requirements.
 - G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Section 07 84 00 - Firestopping.
 - H. Piping in Exterior Pavement:
 - 1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
 - 2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.
 - 3. Maintain 3-inch minimum cover.
 - 4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
 - 5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
 - I. Piping in Interior Reinforced-Concrete Floors:
 - 1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
 - 2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.
 - 3. Maintain 3-inch minimum cover.
 - 4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
 - 5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
 - J. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by DEPARTMENT's Representative.
 - K. After system balancing has been completed, mark balancing valves to permanently indicate final position.
 - L. Perform the following adjustments before operating the system:
 - 1. Open valves to fully open position.
 - 2. Check operation of automatic valves.
 - 3. Set temperature controls so all zones call for full flow.
 - 4. Purge air from piping.

- M. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
 - 1. Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.
 - 2. For freeze protection, operate at a minimum of 60 deg F supply-water temperature.

3.03 FIELD QUALITY CONTROL

- A. Prepare radiant-heating piping for testing as follows:
 - 1. Open all isolation valves and close bypass valves.
 - 2. Open and verify operation of zone control valves.
 - 3. Flush with clean water and clean strainers.
- B. Perform the following tests and inspections:
 - 1. Leak Test: After installation and before pouring of concrete, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Protect hydronic piping system from damage during construction.

END OF SECTION

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

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Copper building wire rated 600 V or less.
 - 2. Metal-clad cable, Type MC, rated 600 V or less.
 - 3. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

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

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.

2.02 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
- D. Ground Conductor: Insulated.
- E. Conductor Insulation:
 - 1. Type THHN/THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- F. Armor: Steel or Aluminum, interlocked.

2.03 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders:
 - 1. Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits:
 - 1. Copper, Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Feeders: Type XHHW-2, single conductors in raceway.
- C. Indoor with Ambient Temperature 32 Deg F Minimum:
 - 1. Branch Circuits: Type THHN/THWN-2 or XHHW-2, single conductors in raceway.
 - 2. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
 - 3. Class 1 Control Circuits: Type THHN/THWN-2 or XHHW-2, in raceway.
 - 4. Class 2 Control Circuits: Type THHN/THWN-2 or XHHW-2, in raceway.
 - a. Power-limited cable, in raceway; or power-limited tray cable, in cable tray where indicated on Drawings.

- D. Outdoor, Wet Locations or Indoor with Ambient Temperature below 32 Deg F:
 - 1. Branch Circuits: Type XHHW-2, single conductors in raceway.
 - 2. Cord Drops and Portable Appliance Connections: Indoor/outdoor; EPDM conductor insulation; CPE jacket; solid rubber non-wicking filler; weather, water, and oil resistant; continuously submersible in water; 105 to minus 50 deg C; 600V Type SOOW-A and 300V Type SJOOW-A hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
 - 3. Class 1 Control Circuits: Type XHHW-2, in raceway.
 - 4. Class 2 Control Circuits: Type XHHW-2, in raceway.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Minimum Conductor Size for Branch Circuits: No. 12 AWG.
 - 1. Use No. 10 AWG minimum for 15 or 20 ampere, 120 volt branch circuits longer than 65 feet but not greater than 100 feet.
 - 2. Use No. 8 AWG minimum for 15 or 20 ampere, 120 volt branch circuits longer than 100 feet unless otherwise indicated.
 - 3. Use No. 10 AWG minimum for 15 or 20 ampere, 277 volt branch circuits longer than 150 feet unless otherwise indicated.
- D. The size of conductors, including equipment grounding conductor, shall remain unchanged for the entire length of the circuit.
 - 1. If conductors are oversized for derating or voltage drop purposes and are too large to land properly on intended devices, downsizing the conductors in the immediate vicinity of the served equipment to suit overcurrent protection is acceptable.
- E. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- F. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- G. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- H. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."
- I. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.
- J. Insulation displacement connectors for power and lighting wiring are not acceptable.

3.04 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 8 inches of slack.

3.05 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section
- C. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.

1.02 ACTION SUBMITTALS

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

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.02 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Bonding Jumper: Braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.03 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Compression Connectors: Tools and dies of types recommended by manufacturer for materials being joined and installation conditions.
 - 1. Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- D. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- E. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- F. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Lay-in Lug Connector: Mechanical type, aluminum or copper rated for direct burial terminal with set screw.
- I. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Bronze.
 - b. Listed for direct burial.

2.04 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.01 APPLICATIONS

- A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
 - 1. Conductor Insulation: Comply with Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
- B. Underground Grounding Conductors: Install bare copper conductor, size as indicated on drawings.
 - 1. Bury at least 24 inches below grade unless otherwise indicated.

- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded or compression connectors except as otherwise indicated.
 - 3. Connections to Structural Steel: Welded or compression connectors.

3.02 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.03 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

- A. Comply with IEEE C2 grounding requirements.
- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- C. Pad-Mounted Transformers and Switches: As indicated on drawings.

3.04 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

3.05 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

- C. Bonding Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. If a disconnect-type connection is required, use a bolted clamp.
- D. Concrete Encased Foundation (UFER) Ground:
 - 1. Install bare ground conductor in footings of minimum length of 20 feet or as shown. Connect Conductors to foundation reinforcement extending to electric service ground point.

3.06 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
 - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify DEPARTMENT's Representative promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Steel slotted support systems.
 - 2. Conduit and cable support devices.
 - 3. Support for conductors in vertical conduit.
 - 4. Structural steel for fabricated supports and restraints.
 - 5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
 - 6. Exterior antenna mounting.
 - 7. Fabricated metal equipment support assemblies.
- B. Related Requirements:
 - 1. Section 26 05 48.16 - Seismic Controls for Electrical Systems for products and installation requirements necessary for compliance with seismic criteria.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For installation details for electrical hangers and support systems.
 - 1. Hangers. Include product data for components.
 - 2. Slotted support systems.
 - 3. Equipment supports.
- C. Delegated-Design Submittal: For hangers and supports for electrical systems.
 - 1. Include design calculations and details of hangers.

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for hangers and supports for electrical equipment and systems, accessories, and components, from manufacturer.

1.04 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design hanger and support system.

- B. Seismic Performance: Hangers and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the supported equipment and systems will remain in place without separation of any parts when subjected to the seismic forces specified and the supported equipment and systems will be fully operational after the seismic event."
- C. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame Rating: Class 1.
 - 2. Self-extinguishing according to ASTM D635.

2.02 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches on center in at least one surface.
 - 1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 2. Material for Channel, Fittings, and Accessories: Galvanized steel, zinc-plated steel, and stainless steel.
 - 3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
- B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized as applicable for location and environment.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.03 EXTERIOR ANTENNA MOUNTING

- A. Description: Stand-offs, 2-inch conduit stem, u-bolts. Sized for antenna. Galvanized or stainless materials and hardware.

2.04 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA 101
 - 3. NECA 102.
 - 4. NECA 105.
 - 5. NECA 111.
- B. Use the following materials:
 - 1. Indoor Dry Locations: Zinc-plated steel.
 - 2. Outdoors and Damp Locations: Galvanized steel.
 - 3. Corrosive Locations: Stainless steel.
- C. Comply with requirements in Section 07 84 00 - Firestopping for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements for raceways and boxes specified in Section 26 05 33 - Raceways and Boxes for Electrical Systems.
- E. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 3/8 inch in diameter.
- F. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps or single-bolt conduit clamps.

3.02 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. For conduits less than 1 inch in diameter, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 6. To Light Steel: Sheet metal screws.
 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ERMC-S raceways, elbows, couplings, and nipples.
3. Type FMC-S and raceways.
4. Type IMC raceways.
5. Type LPMC raceways.
6. Fittings for conduit, tubing, and cable.
7. Threaded metal joint compound.
8. Wireways and auxiliary gutters.
9. Metallic outlet boxes, device boxes, and covers.
10. Termination boxes.
11. Cabinets, cutout boxes, junction boxes, and pull boxes.
12. Cover plates for device boxes.
13. Hoods for outlet boxes.
14. Duct sealant.
15. Handholes and boxes for exterior underground wiring.

B. Related Requirements:

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

1.02 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Floor boxes.
4. Cabinets and cutout boxes.
5. Duct sealant.
6. Handholes and boxes for exterior underground wiring.

PART 2 - PRODUCTS

2.01 TYPE EMT-S RACEWAYS AND ELBOWS

A. Steel Electrical Metal Tubing (EMT-S) and Elbows:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 797 and UL Category Control Number FJMX.
 - b. Material: Steel.
 - c. Exterior Coating: Zinc.
 - d. Interior Coating: Zinc.
 - e. Minimum Trade Size: 1/2 inch.

2.02 TYPE ERM-C-S RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Galvanized-Steel Electrical Rigid Metal Conduit (ERM-C-S-G), Elbows, Couplings, and Nipples:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standards: UL 6 and UL Category Control Number DYIX.
 - b. Exterior Coating: Zinc.
 - c. Interior Coating: Zinc.
 - d. Minimum Trade Size: 1/2 inch.

2.03 TYPE FMC-S AND TYPE RACEWAYS

- A. Steel Flexible Metal Conduit (FMC-S):
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standard: UL 1 and UL Category Control Number DXUZ.
 - b. Material: Steel.
 - c. Minimum Trade Size: 1/2 inch.

2.04 TYPE IMC RACEWAYS

- A. Steel Electrical Intermediate Metal Conduit (IMC):
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standard: UL 1242 and UL Category Control Number DYBY.
 - b. Exterior Coating: Zinc.
 - c. Interior Coating: Zinc.
 - d. Minimum Trade Size: 1/2 inch.

2.05 TYPE LFMC RACEWAYS

- A. Steel Liquidtight Flexible Metal Conduit (LFMC-S):
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standard: UL 360 and UL Category Control Number DXHR.
 - b. Material: Steel.
 - c. Minimum Trade Size: 1/2 inch.

2.06 TYPE HDPE RACEWAYS

- A. High Density Polyethylene Conduit (HDPE):
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:
 - a. Reference Standard: UL 651A.
 - b. Material: High density polyethylene.
 - c. Minimum Trade Size: 1/2 inch.
 - d. Colors: As indicated on Drawings.

2.07 FITTINGS FOR CONDUIT, TUBING, AND CABLE

A. Fittings for Type ERM, Type IMC Raceways:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 514B and UL Category Control Number DWTT.
 - b. Material: Steel.
 - c. Coupling Method: Compression coupling or raintight compression coupling with distinctive color gland nut.
3. Options:
 - a. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - b. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

B. Fittings for Type EMT Raceways:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 514B and UL Category Control Number FKAV.
 - b. Material: Steel.
 - c. Coupling Method: Compression coupling or setscrew coupling.
3. Options:
 - a. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - b. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.

C. Fittings for Type FMC Raceways:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 514B and UL Category Control Number ILNR.

D. Fittings for Type LFMC Raceways:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 514B and UL Category Control Number DXAS.

- E. Fittings for Type HDPE Raceways:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standards: UL 514B.
 - 3. HDPE to ERM C couplers.

2.08 ELECTRICALLY CONDUCTIVE CORROSION-RESISTANT COMPOUNDS FOR THREADED CONDUIT

- A. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and approved by authorities having jurisdiction for application to threaded conduit assemblies.
- B. General Characteristics:
 - 1. Reference Standards: UL 2419 and UL Category Control Number FOIZ.

2.09 WIREWAYS AND AUXILIARY GUTTERS

- A. Metal Wireways and Auxiliary Gutters:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. Reference Standards: UL 870 and UL Category Control Number ZOYX.
 - b. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - c. Finish: Manufacturer's standard enamel finish.
 - 3. Options:
 - a. Degree of Protection: Type 1 or Type 3R unless otherwise indicated.
 - b. Wireway Covers: Screw-cover type unless otherwise indicated.

2.10 METALLIC OUTLET BOXES, DEVICE BOXES, AND COVERS

- A. Metallic Outlet Boxes:
 - 1. Description: Box having pryout openings, knockouts, threaded entries, or hubs in either the sides of the back, or both, for entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting outlet box cover, but without provisions for mounting wiring device directly to box.
 - 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
 - c. Options:
 - 1) Material: Sheet steel or Cast metal.
 - 2) Sheet Metal Depth: Minimum 2.5 inch.
 - 3) Cast-Metal Depth: Minimum 2.4 inch.

- 4) Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb.
- 5) Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.

B. Metallic Conduit Bodies:

1. Description: Means for providing access to interior of conduit or tubing system through one or more removable covers at junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.

C. Metallic Device Boxes:

1. Description: Box with provisions for mounting wiring device directly to box.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL 514A and UL Category Control Number QCIT.
 - c. Options:
 - 1) Material: Sheet steel or cast metal.
 - 2) Sheet Metal Depth: Minimum 2.5 inches.
 - 3) Cast-Metal Depth: Minimum 2.4 inches.
 - 4) Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb.
 - 5) Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb.

2.11 TERMINATION BOXES

- A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
- B. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. Reference Standards: UL 1773 and UL Category Control Number XCKT.
 - b. Listed and labeled for installation on line side of service equipment.
- C. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.

2. General Characteristics:
 - a. Reference Standards: UL 1773 and UL Category Control Number XCKT.
 - b. Listed and labeled for installation on load side of service equipment.

2.12 CABINETS, CUTOOT BOXES, JUNCTION BOXES, AND PULL BOXES

A. Indoor Sheet Metal Cabinets:

1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number CYIV.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 1.

B. Indoor Sheet Metal Cutout Boxes:

1. Description: Enclosure that has swinging doors or covers secured directly to and telescoping with walls of enclosure.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number CYIV.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 1.

C. Indoor Sheet Metal Junction and Pull Boxes:

1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number BGUZ.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.

- c. Options:
 - 1) Degree of Protection: Type 1.
- D. Indoor Cast-Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number BGUZ.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 1.
- E. Outdoor Sheet Metal Cabinets:
 - 1. Description: Enclosure provided with frame, mat, or trim in which swinging door or doors are or can be hung.
 - 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number CYIV.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 3R.
- F. Outdoor Cast-Metal Junction and Pull Boxes:
 - 1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 - 2. Applicable Standards:
 - a. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - b. General Characteristics:
 - 1) Reference Standards: UL Category Control Number BGUZ.
 - a) Non-Environmental Characteristics: UL 50.
 - b) Environmental Characteristics: UL 50E.
 - c. Options:
 - 1) Degree of Protection: Type 3R.

2.13 COVER PLATES FOR DEVICES BOXES

A. Metallic Cover Plates for Device Boxes:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - b. Wallplate-Securing Screws: Metal with head color to match wallplate finish.
3. Options:
 - a. Damp and Wet Locations: Listed, labeled, and marked for location and use. Provide gaskets and accessories necessary for compliance with listing.
 - b. Wallplate Material: Stainless steel unless otherwise indicated on Architectural drawings.

2.14 HOODS FOR OUTLET BOXES

A. Extra-Duty, While-in-Use Hoods for Outlet Boxes:

1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
2. General Characteristics:
 - a. Reference Standards: UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - b. Marked "Extra-Duty" in accordance with UL 514D.
 - c. Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
 - d. Mounts to box using fasteners different from wiring device.
3. Options:
 - a. Provides, weatherproof, "while-in-use" cover.
 - b. Manufacturer may combine nonmetallic device box with hood as extra-duty rated assembly.

2.15 HANDHOLES, BOXES, AND VAULTS FOR EXTERIOR UNDERGROUND WIRING.

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.

B. Type 1 Junction Box:

1. Reinforced concrete with cast iron cover.
2. Outer Dimensions: 20 inches x 14 inches x 12 inches deep, approximate.
3. Designed for flush burial with open bottom unless otherwise indicated.
4. Cover Lettering:
 - a. Match system type.
5. Load Rating: HS-20.

C. Type 2 Junction Box:

1. Reinforced concrete with cast iron cover.
2. Outer Dimensions: 36 inches x 36 inches x 24 inches deep, approximate.

3. Designed for flush burial with open bottom unless otherwise indicated.
4. Cover lettering as shown on the plans.
 - a. Match system type.
5. Load rating: HS-20.

2.16 DUCT SEALANT

A. Water Sealant:

1. Description: Removable two-component, high expansion polyurethane foam, fast-setting, easily installed, easily removed and re-enterable for sealing conduits against water, gas, debris.
2. Conduit sealant for these applications shall be a two-part, high expansion polyurethane foam duct sealant that is fast-setting, easily installed, easily removed and re-enterable.
3. Sealant shall be dispensed with a multi-use, single plunger caulking tube package that automatically mixes the sealant in the correct ratio.
4. Sealant shall create a strong, resilient, chemically resistant seal that is compatible with cable and wire jackets, and will expand, cure, and seal even with water present.

B. Products:

1. American Polywater Corporation FST Foam Sealant.
2. Chemque Q-PAK 2000.
3. Approved equal.

PART 3 - EXECUTION

3.01 SELECTION OF RACEWAYS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult DEPARTMENT's Representative for resolution of conflicting requirements.

B. Outdoors:

1. Exposed Conduit: ERM or IMC.
2. Concealed Conduit, Aboveground: ERM or IMC or EMT.
3. Direct-Buried Conduit: HDPE with ERM for sweeps and stub ups.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

C. Indoors:

1. Hazardous Classified Locations: ERM or IMC.
2. Exposed and Subject to Physical Damage: ERM or IMC. Raceway locations include the following:
 - a. Loading docks.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
3. Exposed, Not Subject to Physical Damage: ERM or IMC or EMT.
4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: ERM or IMC.
6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC or FMC.

- D. Stub-ups to Above Recessed Ceilings: Provide EMT, IMC, or ERM C for raceways.
- E. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
 - 1. ERM C and IMC: Provide threaded type fittings unless otherwise indicated.

3.02 SELECTION OF BOXES AND ENCLOSURES

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult DEPARTMENT's Representative for resolution of conflicting requirements.
- B. Degree of Protection:
 - 1. Outdoors: Type 3R unless otherwise indicated.
 - 2. Indoors: Type 1 unless otherwise indicated.
- C. Exposed Boxes Installed Less Than 6.5 ft. Above Floor:
 - 1. Provide cast-metal boxes.
 - 2. Provide exposed cover. Flat covers with angled mounting slots or knockouts are prohibited.

3.03 INSTALLATION OF RACEWAYS

- A. Installation Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult DEPARTMENT's Representative for resolution of conflicting requirements.
 - 2. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
 - 3. Comply with requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems" for hangers and supports.
 - 4. Comply with NECA NEIS 101 for installation of steel raceways.
 - 5. Comply with NECA NEIS 111 for installation of nonmetallic raceways.
 - 6. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
 - 7. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
 - 8. Raceway Terminations at Locations Subject to Moisture or Vibration: Provide insulating bushings to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conduits.
- B. General Requirements for Installation of Raceways:
 - 1. Complete raceway installation before starting conductor installation.
 - 2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 feet above finished floor.
 - 3. Install no more than equivalent of three 90-degree bends in conduit run. Support within 12 inches of changes in direction.
 - 4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.

5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 6. Support conduit within 36 inches of enclosures to which they are attached.
 7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
 8. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of interior to exterior spaces.
 - b. Where an underground service raceway enters a building or structure.
 - c. Conduit extending from interior to exterior of building.
 - d. Conduit extending into pressurized duct and equipment.
 - e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - f. Where otherwise required by NFPA 70.
 - g. Conduits openings to exterior subgrade locations, unless they are functioning to drain the conduit.
 9. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
 10. Do not install conduits within 2 inches of the bottom side of a metal deck roof.
 11. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
 12. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 13. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- C. Requirements for Installation of Specific Raceway Types:
1. Types ERM and IMC:
 - a. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
 2. Type ERM-S-PVC:
 - a. Follow manufacturer's installation instructions for clamping, cutting, threading, bending, and assembly.
 - b. Provide PVC-coated sealing locknut for exposed male threads transitioning into female NPT threads that do not have sealing sleeves, including transitions from PVC couplings/female adapters to Type ERM-S-PVC elbows in direct-burial applications. PVC-coated sealing locknuts must not be used in place of conduit hub. PVC-coated sealing locknut must cover exposed threads on Type ERM-S-PVC raceway.
 - c. Coat field-cut threads on PVC-coated raceway with manufacturer-approved corrosion-preventing conductive compound prior to assembly.
 3. Types FMC and LFMC: Comply with NEMA RV 3. Provide a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

D. Raceways Embedded in Slabs:

1. Arrange raceways to cross building expansion joints with expansion fittings at right angles to the joint.
2. Arrange raceways to ensure that each is surrounded by a minimum of 2 inches of concrete without voids.
3. Do not embed threadless fittings in concrete unless locations have been specifically approved by DEPARTMENT's Representative.

E. Stub-Ups to Above Recessed Ceilings:

1. Provide EMT, IMC, or ERM for raceways.
2. Provide a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

F. Raceway Fittings: Install fittings in accordance with NEMA FB 2.10 guidelines.

1. ERM-S-PVC: Provide only fittings listed for use with this type of conduit. Patch and seal joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Provide sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
2. EMT: Provide setscrew or compression, steel fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Provide only fittings listed for use with flexible conduit type. Comply with NEMA FB 2.20.

G. Expansion-Joint Fittings:

1. Install in runs of aboveground ERM, IMC, and EMT conduit that are located where environmental temperature change may exceed 100 deg F and that have straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at locations where conduits cross building or structure expansion joints.
5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

H. Raceways Penetrating Rooms or Walls with Acoustical Requirements: Seal raceway openings on both sides of rooms or walls with acoustically rated putty or firestopping.

3.04 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.

- B. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- C. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
- D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- E. Locate boxes so that cover or plate will not span different building finishes.
- F. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- G. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for purpose.
- H. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- I. Set metal floor boxes level and flush with finished floor surface.
- J. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- K. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
- L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- M. Boxes and Enclosures in Areas or Walls with Acoustical Requirements:
 - 1. Seal openings and knockouts in back and sides of boxes and enclosures with acoustically rated putty.
 - 2. Provide gaskets for wallplates and covers.

3.05 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 00 - Firestopping.

3.06 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.07 CLEANING

- A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION

SECTION 26 05 48.16
SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Restraints - rigid type.
 - 2. Restraints - cable type.
 - 3. Restraint accessories.
 - 4. Post-installed concrete anchors.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, and Structural Design Data apply to this Section.
 - 2. Section 26 05 29 - Hangers and Supports for Electrical Systems for commonly used electrical supports and installation requirements.

1.02 COORDINATION

- A. Tests and Inspections:
 - 1. Schedule test with DEPARTMENT, through DEPARTMENT's Representative, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and provide notice at least seven days in advance.
 - 2. Obtain DEPARTMENT's Representative's approval before transmitting test loads to structure. Provide temporary load-spreading members.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated load capacity for each seismic-restraint device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - 3. Annotate types and sizes of seismic restraints and accessories, complete with listing markings or report numbers and load rating in tension and compression as evaluated by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - 4. Annotate to indicate application of each product submitted and compliance with requirements.
- B. Delegated Design Submittal: Signed and sealed by qualified structural professional engineer, for each seismic-restraint device.
 - 1. For each seismic-restraint device that is required by this Section or is indicated on Drawings, submit the following:
 - a. Seismic Restraints: Select seismic restraints complying with performance requirements, design criteria, and analysis data.
 - b. Post-Installed Concrete Anchors and Inserts: Include calculations showing anticipated seismic loads. Include certification that device is approved by an NRTL for seismic reinforcement use.

- c. Seismic Design Calculations: Submit input data and loading calculations.
2. Seismic-Restraint Detail Drawings, signed and sealed by qualified structural professional engineer for equipment and devices as described in Division 26, 27, and section 28 31 11:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint details required for equipment mounted outdoors.
3. Product Listing, Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.04 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of seismic bracing for components with other systems and equipment in the vicinity, including other supports and seismic restraints, in congested areas.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified structural professional engineer to design seismic control system in accordance with criteria specified in Structural Plans.
- B. Seismic-Restraint Device Load Ratings: Devices to be tested and rated in accordance with applicable code requirements and authorities having jurisdiction. Devices to be listed by a nationally recognized third party that requires periodic follow-up inspections and has a listing directory available to the public. Provide third-party listing by one or more of the following: an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- C. Consequential Damage: Provide additional seismic restraints for suspended components or anchorage of floor-, roof-, or wall-mounted components as indicated in ASCE/SEI-7 so that failure of a non-essential or essential component does not cause failure of any other essential building component.
- D. Fire/Smoke Resistance: Seismic-restraint devices that are not constructed of ferrous metals must have a maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested and labeled by an NRTL in accordance with ASTM E84 or UL 723.
- E. Component Supports:
 1. Load ratings, features, and applications of all reinforcement components must be based on testing standards of an NRTL.
 2. All component support attachments must comply with force and displacement resistance requirements of ASCE/SEI-7 Section 13.6

2.02 RESTRAINTS - RIGID TYPE

- A. Description: Shop- or field-fabricated bracing assembly made of ANSI/AISI S110-07-S1 slotted steel channels, ANSI/ASTM A53/A53M steel pipe, or other rigid steel brace member. Includes accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.03 RESTRAINTS - CABLE TYPE

- A. Seismic-Restraint Cables: ASTM A1023/A1023M galvanized or ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for seismic-restraining cable service; with fittings attached by means of poured socket, swaged socket or mechanical (Flemish eye) loop.
- B. Restraint cable assembly and cable fittings must comply with ASCE/SEI 19. Cable fittings and complete cable assembly must maintain the minimum cable breaking force. U-shaped cable clips and wedge-type end fittings do not comply and are unacceptable.

2.04 RESTRAINT ACCESSORIES

- A. Hanger-Rod Stiffener: Steel slotted-support-system sleeve with internally bolted connections or reinforcing steel angle clamped to hanger rod. Non-metallic stiffeners are unacceptable.
- B. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- C. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- D. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- E. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.05 POST-INSTALLED CONCRETE ANCHORS

- A. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength for anchor and as tested according to ASTM E488/E488M.
- B. Provide post-installed concrete anchors that have been prequalified for use in seismic applications.
 - 1. Prequalify post-installed anchors in concrete in accordance with ACI 355.2 or other approved qualification testing procedures.
 - 2. Prequalify post-installed anchors in masonry in accordance with approved qualification procedures.
- C. Expansion-type anchor bolts are not permitted for equipment in excess of 10 hp that is not vibration isolated.
 - 1. Undercut expansion anchors are permitted.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and equipment to receive seismic control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 APPLICATIONS

- A. Use the following materials:
 - 1. Indoor Dry Locations: Zinc-plated steel.
 - 2. Outdoors and Damp Locations: Galvanized steel.
 - 3. Corrosive Locations: Stainless steel.
- B. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
- C. Hanger-Rod Stiffeners: Install where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods caused by seismic forces.
- D. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry static and seismic loads within specified loading limits.

3.03 INSTALLATION OF SEISMIC-RESTRAINT DEVICES

- A. Provide seismic-restraint devices for systems and equipment where indicated in Equipment Schedules or Seismic Controls Schedule, where indicated on Drawings, where the Specifications indicate they are to be installed on specific equipment and systems, and where required by applicable codes.
 - 1. Install equipment and devices to withstand the effects of earthquake motions.
- B. Coordinate location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 03 30 00 "Cast-in-Place Concrete."
- C. Installation of seismic restraints must not cause any stresses, misalignment, or change of position of equipment or conduits.
- D. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.

- E. Raceway, Cable, Wireway, Cable Tray, and Busway Support and Hanger Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- F. Equipment and Hanger Restraints:
 - 1. Install resilient, bolt-isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 2. Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction providing required submittals for component.
- G. Install cables so they do not bend across edges of adjacent equipment or building structure.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members. Contractor may gain approval of alternate attachments with the concurrence of the structural engineer of record.
- J. Post-Installed Concrete Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Mechanical-Type Anchor Bolts: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors must be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Adhesive-Type Anchor Bolts: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - 5. Set anchors to manufacturer's recommended torque using a torque wrench.
 - 6. Install zinc-coated steel anchors for interior and stainless steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where connection is terminated to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

3.05 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by DEPARTMENT's Representative and authorities having jurisdiction.

- B. Tests and Inspections:
 - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - 2. Test no fewer than three of each type and size of installed anchors and fasteners selected by DEPARTMENT's Representative.
 - 3. Test selected anchors and fasteners where the DEPARTMENT suspects a problem with the installation or the anchor appears to be undersized to support the design loading.
 - 4. Test to 90 percent of rated proof load of device.
- C. Seismic controls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Tapes and stencils.
 - 4. Tags.
 - 5. Signs.
 - 6. Cable ties.
 - 7. Paint for identification.
 - 8. Fasteners for labels and signs.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For exterior "Notice" ANSI Z535 style signs. See the plans.
- C. Delegated-Design Submittal: For arc-flash hazard study.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E and Section 26 05 73 "Power System Studies" requirements for arc-flash warning labels.
- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White with colored stripe to match phase for single phase circuits.
 - 3. Color for Equipment Grounds: Bare copper or Green.
- B. Warning Label Colors:
 - 1. Identify system voltage with black letters on an orange background.
- C. Warning labels and signs shall include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
- D. Equipment Identification Labels: Black letters on a white field.

2.03 LABELS

- A. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameter and that stay in place by gripping action.
- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil- thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
- C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.04 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

D. Underground-Line Warning Tape:

1. Tape:
 - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
2. Color and Printing:
 - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
 - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE".
 - c. Inscriptions for Orange-Colored Tapes: " COMMUNICATIONS CABLE ".
3. Description:
 - a. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - b. Width: 3 inches.
 - c. Overall Thickness: 8 mils.
 - d. Foil Core Thickness: 0.35 mil.
 - e. Weight: 34 lb/1000 sq. ft.
 - f. Tensile according to ASTM D882: 300 lbf and 12,500 psi.

E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.05 TAGS

A. Write-on Tags:

1. Polyester Tags: 0.015 inch thick, with corrosion-resistant grommet and cable tie for attachment.
2. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.06 SIGNS

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.

2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- D. Fiberglass:
 1. 25-year minimum life expectancy in exterior conditions.
 2. UV-stabilized.
 3. ANSI Z535 style.

2.07 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F According to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 deg F to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F According to ASTM D638: 7000 psi.
 3. UL 94 Flame Rating: 94V-0.
 4. Temperature Range: Minus 50 to plus 284 deg F.
 5. Color: Black.

2.08 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.
- H. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for emergency operations.
- K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- L. Snap-Around Labels: Secure tight to surface at a location with high visibility and accessibility.
- M. Self-Adhesive Wraparound Labels: Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
- N. Self-Adhesive Labels:
 - 1. On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- O. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- P. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
 - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- Q. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- R. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

- S. Underground Line Warning Tape:
 - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
 - 2. Limit use of underground-line warning tape to direct-buried cables.
 - 3. Install underground-line warning tape for direct-buried cables and cables in raceways.

- T. Write-on Tags:
 - 1. Place in a location with high visibility and accessibility.
 - 2. Secure using general-purpose cable ties.

- U. Baked-Enamel Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

- V. Metal-Backed Butyrate Signs:
 - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

- W. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
 - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

- X. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.02 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

- C. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with paint; the raceways shall be identified with a 6-inch band of paint at 10-foot maximum intervals. Color coding shall be as follows:
 - 1. 208Y/120V Power – White.
 - 2. Telephone – Blue.

- D. Junction Box Identification: Label junction boxes with the following information.
 - 1. System.
 - 2. Panel and circuit.
 - 3. If there are multiple circuits, identify conductors.
- E. Receptacles: Identify each receptacle with panelboard identification and circuit number. Use clear, self-adhesive vinyl label with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- F. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use self-adhesive vinyl tape to identify the phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive wraparound labels with the conductor or cable designation, origin, and destination.
- H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive wraparound labels with the conductor designation.
- I. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source, and use color-coding conductor tape to identify the phase.
- J. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- K. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- L. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive equipment labels.
 - 1. Apply to exterior of door, cover, or other access.
- O. Arc Flash Warning Labeling: Self-adhesive labels.
- P. Operating Instruction Signs: Laminated acrylic or melamine plastic signs.
- Q. Emergency Operating Instruction Signs: Laminated acrylic or melamine plastic signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for emergency operations.
- R. Notice Signs: Fiberglass

- S. Equipment Identification Labels:
1. Indoor Equipment: Laminated acrylic or melamine plastic sign.
 2. Outdoor Equipment: Laminated acrylic or melamine sign.

END OF SECTION

**SECTION 26 05 73
POWER SYSTEM STUDIES**

PART 1 - GENERAL

1.1 SUMMARY

A. The Work of this Section Includes:

1. Short-circuit study.
2. Arc-flash hazard study.

1.2 ACTION SUBMITTALS

A. Product Data: For power system analysis software to be used for studies.

1. Product Certificates: For power system study software applications, include certificate stating compliance with specified requirements, signed by software manufacturer.

B. Power System Study Reports:

1. Submit reports after approval of system protective devices submittals. Submittals must be in digital form.
2. Submit short-circuit study input data, including completed computer-program input data sheets.
3. Submit arc-flash study input data, including completed computer-program input data sheets.
4. Submit study report for action prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Architect for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.

C. Data files for studies in format compatible with Owner's power system analysis software.

1.3 QUALITY ASSURANCE

- A. Submittals for power system studies must be signed and sealed by qualified electrical professional engineer responsible for their preparation.
- B. Studies must be performed using commercially developed and distributed software designed specifically for power system analysis.
- C. Software algorithms must comply with requirements of standards and guides specified in this Section.
- D. Manual calculations are unacceptable.

PART 2 - PRODUCTS

2.1 POWER SYSTEM ANALYSIS SOFTWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. SKM Systems Analysis.

B. Standard Features:

1. Power System Analysis:

- a. Power-systems-analysis software applications must have analytical capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 3002 series standards.
- b. Computer software application must be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program must report device settings and ratings of overcurrent protective devices and must demonstrate selective coordination by computer-generated, time-current coordination plots.
- c. Computer software application must be designed to perform arc-flash analysis or have function, component, or add-on module designed to perform arc-flash analysis.

2. Analysis Standards:

- a. Short-Circuit Current Analysis: In accordance with IEEE 3002.3.
- b. Arc-Flash Hazard Analysis: In accordance with IEEE 1584.

3. Capable of printing arc-flash hazard warnings for equipment on weather- and UV-resistant, pressure-sensitive adhesive labels complying with NFPA 70E.

- a. Label must have orange header with wording, "WARNING, ARC-FLASH HAZARD," and must include the following information taken directly from arc-flash hazard study:

- 1) Equipment designation.
- 2) Nominal voltage.
- 3) Protection boundaries.
 - a) Arc-flash boundary.
 - b) Restricted approach boundary.
 - c) Limited approach boundary.
- 4) Arc-flash PPE category.
- 5) Required minimum arc rating of PPE in Cal/cm squared.
- 6) Available incident energy.
- 7) Working distance.
- 8) Engineering report number, revision number, and issue date.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Collect and analyze data for power system studies.
1. Verify completeness of data supplied in one-line diagram on Drawings. Call discrepancies to Owner's attention.
 2. For equipment included as Work on the Project, use characteristics submitted under provisions of action submittals and information submittals for the Project.
 3. Gather and tabulate required input data to support power system studies. Comply with requirements in Section 017839 "Project Record Documents" for recording circuit protective device characteristics. Record data on Record Document copy of one-line diagram. Comply with recommendations in IEEE 3002 series standards as to amount of detail that is required to be acquired in field. Field data gathering must be by, or under supervision of, qualified electrical professional engineer. Data include, but are not limited to, the following:
 - a. Product data for the Project's overcurrent protective devices involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 - b. Electrical power utility impedance at service.
 - c. Short-circuit current at each system bus (three phase and line to ground).
 - d. Full-load current of loads.
 - e. Voltage level at each bus.
 - f. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 - g. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 - h. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).

3.2 POWER SYSTEM STUDY REPORTS

- A. Preparation of Power System Study Reports: Prepare and submit the following:
1. Short-Circuit Study Report Contents:
 - a. Executive summary of study findings.
 - b. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
 - c. One-line diagram of modeled power system, showing the following:
 - 1) Protective device designations and ampere ratings.
 - 2) Conductor types, sizes, and lengths.
 - 3) Transformer kVA and voltage ratings.

- 4) Motor and generator designations and kVA ratings.
 - 5) Switchgear, switchboard, motor-control center, and panelboard designations and ratings.
 - 6) Derating factors and environmental conditions.
 - 7) Revisions to electrical equipment required by study.
- d. Comments and recommendations for system improvements or revisions in written document, separate from one-line diagram.
- e. Short-Circuit Study Input Data:
 - 1) One-line diagram of system being studied.
 - 2) Power sources available.
 - 3) Manufacturer, model, and interrupting rating of protective devices.
 - 4) Conductors.
 - 5) Transformer data.
- f. Protective Device Evaluation:
 - 1) Evaluate equipment and protective devices and compare to available short-circuit currents. Verify that equipment withstand ratings exceed available short-circuit current at equipment installation locations.
 - 2) Tabulations of circuit breaker, fuse, and other protective device ratings versus calculated short-circuit duties.
 - 3) For 600 V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
 - 4) For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in standards to 1/2-cycle symmetrical fault current.
 - 5) Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
- g. Short-Circuit Study Output Reports:
 - 1) Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a) Voltage.
 - b) Calculated fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) Equivalent impedance.
 - 2) Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a) Voltage.
 - b) Calculated symmetrical fault-current magnitude and angle.
 - c) Fault-point X/R ratio.

- d) Calculated asymmetrical fault currents based on fault-point X/R ratio; based on calculated symmetrical value multiplied by 1.6; and based on calculated symmetrical value multiplied by 2.7.
- 3) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a) Voltage.
 - b) Calculated symmetrical fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) No AC Decrement (NACD) ratio.
 - e) Equivalent impedance.
 - f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
- h. Executive summary of study findings.
- i. Study descriptions, purpose, basis, and scope. Include case descriptions, definition of terms, and guide for interpretation of results.
- j. One-line diagram, showing the following:
 - 1) Protective device designations and ampere ratings.
 - 2) Conductor types, sizes, and lengths.
 - 3) Transformer kVA and voltage ratings, including derating factors and environmental conditions.
 - 4) Motor and generator designations and kVA ratings.
 - 5) Switchgear, switchboard, motor-control center, panelboard designations, and ratings.
- k. Short-circuit study output data.
- l. Arc-Flash Study Output Reports:
 - 1) Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each equipment location included in report:
 - a) Voltage.
 - b) Calculated symmetrical fault-current magnitude and angle.
 - c) Fault-point X/R ratio.
 - d) No AC Decrement (NACD) ratio.
 - e) Equivalent impedance.
 - f) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on symmetrical basis.
 - g) Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on total basis.
- m. Incident Energy and Flash Protection Boundary Calculations:
 - 1) Arcing fault magnitude.
 - 2) Protective device clearing time.
 - 3) Duration of arc.

- 4) Arc-flash boundary.
 - 5) Restricted approach boundary.
 - 6) Limited approach boundary.
 - 7) Working distance.
 - 8) Incident energy.
 - 9) Hazard risk category.
 - 10) Recommendations for arc-flash energy reduction.
- n. Fault study input data, case descriptions, and fault-current calculations including definition of terms and guide for interpretation of computer printout.

3.3 WARNING LABELING OF ARC-FLASH HAZARDS

- A. Apply arc-flash label on front cover for each equipment included in study, including each piece of equipment listed below:
1. Service Disconnect
 2. Panelboards.
- B. Base arc-flash label data on highest values calculated at each location.
- C. Machine print warning labels with no handwritten or field-applied markings.

END OF SECTION

**SECTION 26 09 23
LIGHTING CONTROL DEVICES**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Photoelectric switches.
 - 2. Lighting contactors.
- B. Related Requirements:
 - 1. Section 26 27 26 - Wiring Devices for manual light switches.
 - 2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Interconnection diagrams showing field-installed wiring.
 - 2. Include diagrams for power, signal, and control wiring.
 - 3. Lighting contactor and momentary switches wiring.

1.03 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with SPST dry contacts rated for 600 VA minimum LED, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
 - 3. Time Delay: Fifteen-second minimum, to prevent false operation.
 - 4. Surge Protection: Metal-oxide varistor.
 - 5. Mounting: Base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
 - 6. Failure Mode: Luminaire stays ON.

2.02 LIGHTING CONTACTORS

- A. Description: Electrically operated and mechanically held, combination-type lighting contactors with non-fused disconnect, complying with NEMA ICS 2 and UL 508.
 - 1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
 - 2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
 - 3. Enclosure: Comply with NEMA 250.
 - 4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- B. Control Devices: On/off control with momentary devices from multiple locations, compatible with contactor.

2.03 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Type of cable according to lighting control device manufacturer's written instruction, but not smaller than No. 22 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.

- B. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture-damaged, or mold-damaged.
- C. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- D. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.02 WIRING INSTALLATION

- A. Wiring Method: Comply with Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables. Minimum conduit size is 1/2 inch.
- B. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's written instructions.
- C. Size conductors in accordance with lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.03 IDENTIFICATION

- A. Identify components and power and control wiring in accordance with Section 26 05 53 - Identification for Electrical Systems.
- B. Label time switches and contactors with a unique designation.

3.04 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.05 DEMONSTRATION

- A. Train DEPARTMENT's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION

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SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes: Distribution, dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.
- B. Related Sections:
 - 1. Section 26 05 48.16 - Seismic Controls for Electrical Systems for products and installation requirements necessary for compliance with seismic criteria.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Include diagrams for power, signal, and control wiring.

1.04 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For transformers, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

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

1.06 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.02 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.
- D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coils: Continuous windings without splices except for taps.
 - 1. Internal Coil Connections: Brazed or pressure type.
- F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.03 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Provide transformers that are constructed to withstand seismic forces specified in Section 26 05 48.16 - Seismic Controls for Electrical Systems.
- C. Step up vs step down transformers.
 - 1. Designed for step up where stepping voltage up.
 - 2. Designed for step down where stepping voltage down.
- D. Cores: One leg per phase.

- E. Enclosure, Indoor: Ventilated.
 - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: Gray.
- G. Taps for Transformers 3 kVA and Smaller: None.
- H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.
- K. Neutral: Rated 200 percent of full load current for K-factor rated transformers.
- L. Wall Brackets: Manufacturer's standard brackets.
- M. Fungus Proofing: Permanent fungicidal treatment for coil and core.

2.04 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws or VHB tape. Nameplates and label products are specified in Section 26 05 53 - Identification for Electrical Systems.

2.05 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
 - 2. Ratio tests at the rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at the rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 - 9. Temperature tests.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and requirements in Section 26 05 26 - Grounding and Bonding for Electrical Systems have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
 - 2. Brace wall-mounted transformers as specified in Section 26 05 48.16 - Seismic Controls for Electrical Systems.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to Section 03 30 00 - Cast-in-Place Concrete and anchor floor-mounted transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Section 26 05 29 - Hangers and Supports for Electrical Systems.
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- E. Remove shipping bolts, blocking, and wedges.

3.03 CONNECTIONS

- A. Ground equipment according to Section 26 05 26 - Grounding and Bonding for Electrical Systems.
- B. Connect wiring according to Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.04 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Perform tests and inspections and prepare test reports.
- C. Tests and Inspections: Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
- D. Remove and replace units that do not pass tests or inspections and retest as specified above.
- E. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
 - 1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
 - 2. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
- F. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.05 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.
- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

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**SECTION 26 24 16
PANELBOARDS**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes Specification Types:
 - 1. Distribution panelboards.
 - a. DPB – Distribution Panelboards; Circuit Breaker Branches.
 - 2. Lighting and appliance branch-circuit panelboards.
 - a. BPB – Branch-Circuit Panelboards; Circuit Breaker Branches.
- B. Related Requirements:
 - 1. Section 26 28 14 - Circuit Breakers for molded-case circuit breakers.
 - 2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 DEFINITIONS

- A. MCCB: Molded-case circuit breaker.
- B. SPD: Surge protective device.

1.03 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of panelboard.
 - 2. For molded-case circuit breakers installed in panelboards.
 - 3. For insulated-case circuit breakers installed in panelboards.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. For custom-built panels: Include dimensioned plans, elevations, sections, and details.
 - 2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Include evidence of NRTL listing for SPD as installed in panelboard.
 - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards.

1.04 INFORMATIONAL SUBMITTALS

- A. Panelboard schedules for installation in panelboards.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANELBOARDS COMMON REQUIREMENTS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 26 05 48.16 "Seismic Controls for Electrical Systems."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Flush and surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 5.
 - 2. Height: 84 inches maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
- F. Incoming Mains Location: To suit installation unless indicated otherwise on Drawings.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Tin-plated aluminum.
 - 2. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 - 3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 - 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

- H. NRTL Label: Panelboards shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.02 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
- B. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 2.

2.03 DISTRIBUTION PANELBOARDS

- A. Panelboards: NEMA PB 1, distribution type.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches minimum.
- C. Mains: As indicated on Drawings.
- D. Branch Overcurrent Protective Devices: Plug-in circuit breakers or Bolt-on circuit breakers.
 - 1. Plug-in circuit breakers require individual positive-locking device requiring mechanical release for removal.
- E. Surge Protective Devices.
 - 1. Surge current rating minimum 80,000 amperes for L-L mode; 40,000 amperes for other modes.
 - 2. Maximum L-N and N-G voltage protection rating, 1200V for 480Y/277V, 600V for 208Y/120V.
 - 3. Maximum L-G voltage protection rating, 1200V for 480Y/277V, 700 for 208Y/120V.
 - 4. Maximum L-L voltage protection rating, 1800V for 480Y/277V, 1200V for 208Y/120V.
 - 5. UL 1449.

2.04 BRANCH-CIRCUIT PANELBOARDS

- A. Panelboards: NEMA PB 1, branch-circuit type.
- B. Mains: As indicated on Drawings.
- C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- D. Contactors in Main Bus: NEMA ICS 2, Class A, electrically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity as indicated to meet available fault currents.
 - 1. Comply with the requirements specified in Section 26 28 14 - Circuit Breakers.

2.06 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card mounted inside panelboard door with transparent plastic protective cover.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NECA 407.
- C. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 - Seismic Controls for Electrical Systems.
- D. Mount panelboards such that the operating handle of the top-most switch or circuit breaker, in on position, is not higher than 79 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box.
- F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Install overcurrent protective devices and controllers not already factory-installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- H. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- I. Install filler plates in unused spaces.
- J. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- K. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

- L. Coordinate circuit breaker ratings with equipment ratings supplied by others.

3.02 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."
- B. Create a directory to indicate final installed circuit loads; incorporate DEPARTMENT's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 - Identification for Electrical Systems.
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 - Identification for Electrical Systems.
- E. Install warning signs complying with requirements in Section 26 05 53 - Identification for Electrical Systems identifying source of remote circuit.

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

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**SECTION 26 27 13
ELECTRICITY METERING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes work to accommodate utility company revenue meters.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

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

1.03 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.04 COORDINATION

- A. Electrical Service Connections: Coordinate with utility company and utility-furnished components.
 - 1. Coordinate with utility for inspection and acceptance of installation; utility normally terminates Contractor-installed Utility Metering wiring.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 916.

2.02 UTILITY METERING INFRASTRUCTURE

- A. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.
- B. Meter Sockets:
 - 1. Comply with requirements of electrical-power utility company.
 - 2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.
- C. Arc-Flash Warning Labels:
 - 1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 26 05 73 "Power System Studies." Apply a properly sized self-adhesive label at each work location included in the analysis.

2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 26 05 53 - Identification for Electrical Systems. Apply a properly sized self-adhesive label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
 - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1) Location designation.
 - 2) Nominal voltage.
 - 3) Flash protection boundary.
 - 4) Hazard risk category.
 - 5) Incident energy.
 - 6) Working distance.
 - 7) Engineering report number, revision number, and issue date.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.
- C. Install arc-flash labels as required by NFPA 70.
- D. Wiring Method:
 1. Comply with requirements in Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
 2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 27 15 13 - Communications Copper Horizontal Cabling.
 3. Minimum conduit size shall be 1/2 inch.
- E. Comply with requirements for identification specified in Section 26 05 53 - Identification for Electrical Systems.

END OF SECTION

**SECTION 26 27 26
WIRING DEVICES**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Standard-grade receptacles, 125 V, 20 A.
 - 2. GFCI receptacles, 125 V, 20 A.
 - 3. Special purpose receptacles.
 - 4. Toggle switches, 120/277 V, 20 A.
 - 5. Wall plates.
 - 6. Lockout wall plate.

1.03 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.01 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. RoHS compliant.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with requirements in this Section.
- F. Devices for DEPARTMENT-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.
- G. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by DEPARTMENT's Representative unless otherwise indicated or required by NFPA 70 or device listing.
- H. Wall Plate Color: For plastic covers, match device color.
- I. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.02 STANDARD-GRADE RECEPTACLES, 125 V, 20 A

- A. Duplex Receptacles, 125 V, 20 A:
 - 1. Description: Two-pole, three-wire, and self-grounding.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Standards: Comply with UL 498 and FS W-C-596.
- B. Weather-Resistant Duplex Receptacle, 125 V, 20 A:
 - 1. Description: Two-pole, three-wire, and self-grounding. Square face.
 - 2. Configuration: NEMA WD 6, Configuration 5-20R.
 - 3. Standards: Comply with UL 498.
 - 4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.03 GFCI RECEPTACLES, 125 V, 20 A

- A. Duplex GFCI Receptacles, 125 V, 20 A:
 - 1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding.

2. Configuration: NEMA WD 6, Configuration 5-20R.
 3. Type: Non-feed through.
 4. Standards: Comply with UL 498, UL 943 Class A, and FS W-C-596.
- B. Weather-Resistant, GFCI Duplex Receptacles, 125 V, 20 A:
1. Description: Integral GFCI with "Test" and "Reset" buttons and LED indicator light. Two-pole, three-wire, and self-grounding. Square face.
 2. Configuration: NEMA WD 6, Configuration 5-15R.
 3. Type: Non-feed-through.
 4. Standards: Comply with UL 498 and UL 943 Class A.
 5. Marking: Listed and labeled as complying with NFPA 70, "Tamper-Resistant Receptacles" and "Receptacles in Damp or Wet Locations" articles.

2.04 SPECIAL PURPOSE RECEPTACLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
 2. Leviton Manufacturing Co., Inc.
 3. Pass & Seymour/Legrand (Pass & Seymour).
- B. Description:
1. NEMA 6-30R.
 2. NEMA 14-30R.
 3. Match voltage, current rating, and configuration to requirements of equipment being connected.

2.05 TOGGLE SWITCHES, 120/277 V, 20 A

- A. Single-Pole Switches, 120/277 V, 20 A: Standards: Comply with UL 20 and FS W-S-896.
- B. Two-Pole Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.
- C. Three-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.
- D. Four-Way Switches, 120/277 V, 20 A: Comply with UL 20 and FS W-S-896.

2.06 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
 2. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
 3. Material for Unfinished Spaces: Galvanized steel.
 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, "extra duty" die-cast aluminum while-in-use with lockable cover.

2.07 LOCKOUT WALLPLATE

- A. Wall plate with raised tabs that allow insertion of a locking device to lock the switch in the on or off position.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes, and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall comply with NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation: Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets to suit arrangement of furnishings.

3.02 GFCI RECEPTACLES

- A. Install non-feed-through GFCI receptacles.

3.03 IDENTIFICATION

- A. Comply with Section 26 05 53 - Identification for Electrical Systems.
- B. Identify each receptacle with panelboard identification and circuit number. Use clear, self-adhesive vinyl label with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.04 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections:
 - 1. Test Instruments: Use instruments that comply with UL 1436.
 - 2. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault-current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

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**SECTION 26 28 14
CIRCUIT BREAKERS**

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section includes circuit breakers rated 600-V ac and less for use in enclosed breakers, panelboards, switchboards, enclosed controllers, and motor-control centers.
 - 1. Molded Case Circuit Breakers.
 - 2. Insulated Case Circuit Breakers.

1.03 SUBMITTALS

- A. Provide circuit breaker submittal under specification section number corresponding to the assembly the circuit breaker is enclosed in.
- B. DO NOT provide submittal material under this specification number.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain circuit breakers, for use within a specific product, from the manufacturer of the product the breaker is enclosed in.

1.05 PROJECT CONDITIONS

- A. As indicated for assembly the circuit breaker is enclosed in.

1.06 COORDINATION

- A. As indicated for assembly the circuit breaker is enclosed in.

PART 2 - PRODUCTS

2.01 MOLDED-CASE CIRCUIT BREAKERS

- A. General Requirements: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- B. Thermal-Magnetic Circuit Breakers (MTM): Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 1. Circuit breakers not designated with a "type" acronym or other feature on the Drawings is a thermal-magnetic circuit breaker.
- C. Adjustable Instantaneous-Trip Circuit Breakers (MIT): Magnetic trip element with front-mounted, field-adjustable trip setting.

- D. Electronic trip-unit circuit breakers (MET) shall be digital True RMS sensing, with field-replaceable rating plug.
 - 1. Padlocking Provisions for all MET breakers: For installing at least one padlock on each circuit breaker to prevent closure of the circuit breaker.
- E. Current-Limiting Circuit Breakers (MCL): Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
- F. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical or compression style, suitable for number, size, trip ratings, and conductor material.
 - 2. Application Listing: Appropriate for application:
 - a. Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Padlocking Provisions: For installing at least one padlock on each circuit breaker to prevent closure of the circuit breaker.
 - 4. Shunt Trip (STx): Trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
 - a. If no entry is made for "x" variable shunt trip coil is 120 VAC set to trip at 55 percent of rated voltage.
 - b. Other voltages indicated by changing character "x", for example 24VDC indicates 24 volts direct current; 120VAC is 120 volts alternating current.
 - 5. Ground-Fault Interrupting Circuit Breakers: Single- and two-pole configurations:
 - a. 5 mA trip sensitivity (GFCI).
 - b. 30 mA trip sensitivity (GFEP).

2.02 ELECTRONIC TRIP UNIT (CIRCUIT BREAKER TYPES MET AND IC).

- A. Where features and accessories listed for Molded-Case and Insulated-Case Circuit Breakers above are indicated, an Electronic Trip Unit equipped circuit breaker with suitable accessories may be utilized to meet the requirements.
- B. Digital microprocessor-based trip unit, true RMS sensing, with field-replaceable rating plug, and the following field-adjustable settings:
 - 1. Long-time pickup level (L).
 - 2. Short-time pickup level (S).
 - 3. Short-time time adjustment, switchable flat or I2t response.
 - 4. Instantaneous trip pickup level (I).
 - 5. Ground-fault pickup level, time delay, and switchable I2t response (G).

PART 3 - EXECUTION

3.01 GENERAL

- A. As indicated for assembly the circuit breaker is enclosed in.

END OF SECTION

SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Non-fusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Enclosures.
- B. Related Requirements:
 - 1. Section 26 28 14 - Circuit Breakers for molded-case and insulated-case circuit breakers.
 - 2. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.

1.03 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: For enclosed switches and circuit breakers, accessories, and components, from manufacturer.
- C. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.06 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.03 FUSIBLE SWITCHES

- A. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 240-V and 600-V ac.
 - 4. 600 A and smaller.
 - 5. Service and building disconnects: use class R fuses.
 - 6. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses.
 - 7. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- B. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.04 NONFUSIBLE SWITCHES

- A. Type GD, General Duty, Three Pole, Single Throw, 240-V ac, 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

- B. Type HD, Heavy Duty, Three Pole, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Six Pole, Single Throw, 240-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Type HD, Heavy Duty, Three Pole, Double Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- E. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Service-Rated Switches: Labeled for use as service equipment.

2.05 MOLDED-CASE CIRCUIT BREAKERS

- A. Comply with requirements specified in Section 26 28 14 "Circuit Breakers."
- B. Standards: Comply with UL 489 with interrupting capacity to comply with available fault currents.

2.06 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) or gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover or directly operable through the front cover of the enclosure (NEMA 250 Type 1) or directly operable through the dead front trim of the enclosure (NEMA 250 Type 3R). The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- E. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- F. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.01 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.02 INSTALLATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by DEPARTMENT or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify DEPARTMENT no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without DEPARTMENT's written permission.
 - 4. Comply with NFPA 70E.
- B. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- D. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 - Seismic Controls for Electrical Systems.
- E. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Install fuses in fusible devices.
- G. Comply with NFPA 70 and NECA 1.

3.03 IDENTIFICATION

- A. Comply with requirements in Section 26 05 53 - Identification for Electrical Systems.
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

- A. Perform tests and inspections.

B. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, grounding, and clearances.
- c. Verify that the unit is clean.
- d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
- e. Verify that fuse sizes and types match the Specifications and Drawings.
- f. Verify that each fuse has adequate mechanical support and contact integrity.
- g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
- i. Verify correct phase barrier installation.
- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Measure contact resistance across each switchblade fuseholder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."

C. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.

- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

2. Electrical Tests:

- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
- c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
- e. Determine the following by primary current injection:
 - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
 - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.

- f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
 - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
 - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.
 - i. Verify operation of charging mechanism. Investigate units that do not function as designed.
 - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

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SECTION 26 29 13.03 - MANUAL AND MAGNETIC MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Manual motor controllers.
 - 2. Enclosed full-voltage magnetic motor controllers.
 - 3. Enclosures.
 - 4. Accessories.
 - 5. Identification.
- B. Section Excludes:
 - 1. Variable Frequency Equipment Drives.
- C. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of magnetic controller.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Indicate dimensions, weights, required clearances, and location and size of each field connection.
 - 3. Wire Termination Diagrams and Schedules: Include diagrams for signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Include features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for magnetic controllers, from manufacturer.
- B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. UL Compliance: Fabricate and label magnetic motor controllers to comply with UL 508 and UL 60947-4-1.
- C. NEMA Compliance: Fabricate motor controllers to comply with ICS 2.
- D. Seismic Performance: Magnetic controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the controller will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.02 MANUAL MOTOR CONTROLLERS

- A. Motor-Starting Switches (MSS): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
 - 1. Standard: Comply with NEMA ICS 2, general purpose, Class A.
 - 2. Configuration: Non-reversing.
 - 3. Surface mounting.
 - 4. Red pilot light.
- B. Fractional Horsepower Manual Controllers (FHPMC): "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
 - 1. Configuration: Non-reversing.
 - 2. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type or melting alloy type.
 - 3. Overload Relays: NEMA ICS 2, bimetallic class as schedule on Drawings.
 - 4. Pilot Light: Red.

2.03 ENCLOSED FULL-VOLTAGE MAGNETIC MOTOR CONTROLLERS

- A. Description: Across-the-line start, electrically held, for nominal system voltage of 600-V ac and less.
- B. Standard: Comply with NEMA ICS 2, general purpose, Class A.
- C. Configuration: Non-reversing.
- D. Contactor Coils: Pressure-encapsulated type.
 - 1. Operating Voltage: Manufacturer's standard, unless indicated.

- E. Control Power: For on-board control power, obtain from line circuit or from integral Control Power Transformer (CPT). The CPT shall have capacity to operate integral devices and remotely located pilot, indicating, and control devices.
- F. Overload Relays:
 - 1. Thermal Overload Relays:
 - a. Inverse-time-current characteristic.
 - b. Class 20 tripping characteristic.
 - c. Heaters in each phase shall be matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
 - d. Ambient compensated.
 - e. Automatic resetting.
 - 2. Solid-State Overload Relay:
 - a. Switch or dial selectable for motor-running overload protection.
 - b. Sensors in each phase.
 - c. Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
 - d. Class II ground-fault protection shall comply with UL 1053 to interrupt low-level ground faults. The ground-fault detection system shall include circuitry that will prevent the motor controller from tripping when the fault current exceeds the interrupting capacity of the controller. Equip with start and run delays to prevent nuisance trip on starting, and a trip indicator.

2.04 ENCLOSURES

- A. Comply with NEMA 250, type designations as indicated on Drawings, complying with environmental conditions at installed location.
- B. The construction of the enclosures shall comply with NEMA ICS 6.

2.05 ACCESSORIES

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
 - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty, except as needed to match enclosure type. Heavy-duty or oil-tight where indicated in the controller schedule.
 - a. Push Buttons: As indicated in the controller schedule.
 - b. Pilot Lights: As indicated in the controller schedule.
- B. Motor protection relays shall be with solid-state sensing circuit and isolated output contacts for hardwired connections.
 - 1. Phase-failure.
 - 2. Phase-reversal, with bicolor LED to indicate normal and fault conditions. Automatic reset when phase reversal is corrected.
 - 3. Under/overvoltage, operate when the circuit voltage reaches a preset value, and drop out when the operating voltage drops to a level below the preset value. Include adjustable time-delay setting.

2.06 IDENTIFICATION

- A. Controller Nameplates: Laminated acrylic or melamine plastic signs, as described in Section 26 05 53 "Identification for Electrical Systems", for each compartment, mounted with corrosion-resistant screws.
- B. Arc-Flash Warning Labels:
 - 1. Comply with requirements in Section 26 05 53 "Identification for Electrical Systems." Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.
 - a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1) Location designation.
 - 2) Nominal voltage.
 - 3) Flash protection boundary.
 - 4) Hazard risk category.
 - 5) Incident energy.
 - 6) Working distance.
 - 7) Engineering report number, revision number, and issue date.
 - b. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install magnetic controllers on walls with tops at uniform height indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 26 05 29 "Hangers and Supports for Electrical Systems" unless otherwise indicated.
- C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete".
- D. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems".
- E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- G. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

3.02 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems".

3.03 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Comply with the provisions of NFPA 70B, "Testing and Test Methods" Chapter.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with drawings and specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, and grounding.
 - d. Verify the unit is clean.
 - e. Inspect contactors:
 - 1) Verify mechanical operation.
 - 2) Verify contact gap, wipe, alignment, and pressure are according to manufacturer's published data.
 - f. Motor-Running Protection:
 - 1) Verify overload element rating is correct for its application.
 - 2) If motor-running protection is provided by fuses, verify correct fuse rating.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter. Compare bolted connection resistance values with values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - 3. Electrical Tests:
 - a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Insulation-resistance values shall be according to manufacturer's published data or NETA ATS Table 100.1. In the absence of manufacturer's published data, use Table 100.5. Values of insulation resistance less than those of this table or manufacturer's recommendations shall be investigated and corrected.
 - b. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - c. Test motor protection devices according to manufacturer's published data.
 - d. Test circuit breakers as follows:
 - 1) Operate the circuit breaker to ensure smooth operation.
 - 2) For adjustable circuit breakers, adjust protective device settings according to the coordination study. Comply with coordination study recommendations.
 - e. Perform operational tests by initiating control devices.
- C. Motor controller will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

3.04 SYSTEM FUNCTION TESTS

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality control tests have been completed and all components have passed specified tests.
 - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
 - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
 - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Motor controller will be considered defective if it does not pass the system function tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

**SECTION 26 51 19
LED LIGHTING**

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes the following LED luminaires and related items:
 - 1. LED luminaires.
 - 2. Materials.
 - 3. Luminaire support
 - 4. Emergency Battery-Inverter.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description and dimensions of luminaires.
 - 3. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 4. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products
- B. Product Schedule: For luminaires. Use same designations indicated on Drawings.

1.03 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For luminaires, accessories, and components, from manufacturer.
- B. Product Certificates: For each type of luminaire.
- C. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.06 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Luminaires shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
- B. Seismic Performance: Luminaires shall be labeled vibration and shock resistant.
 - 1. The term "withstand" means "the luminaire will remain in place without separation of any parts when subjected to the seismic forces specified and the luminaire will be fully operational during and after the seismic event."

2.02 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Recessed luminaires shall comply with NEMA LE 4.
- C. LED driver percent flicker less than 10%.
- D. See Drawings for Luminaire Schedule.

2.03 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
 - 1. Manufacturer's standard grade.
 - 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Components are designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during servicing and when secured in operating position.

G. Diffusers:

1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation, unless otherwise indicated.

2.04 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are relatively minor and if they can be and are assembled or installed to minimize contrast.

2.05 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gauge; or as recommended by luminaire manufacturer
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Swivel Pendant: ball type swivel hanger cover, 50 lbs. support, 20-degree swing from vertical.

2.06 EMERGENCY BATTERY-INVERTER REQUIREMENTS

- A. General characteristics include:
1. UL 924; 90-minute run time.
 2. Wattage: See Drawings. Confirm with manufacturer that it is sized for the load.
 3. Input/Output Voltage: See Drawings.
 4. Suitable for switched load.
 5. Transfer time less than 2 msec.
 6. Lead calcium battery.
 7. Pure sine wave output.
 8. THD less than 3 percent.

2.07 EMERGENCY LIGHTING

- A. Emergency Luminaires:
1. Emergency Luminaires: As indicated on Drawings.
- B. Emergency Lighting Unit:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.
 2. Internal emergency power unit.
 3. Remote Emergency Lighting Units: Companion product to lighting units indicated on Drawings.

2.08 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction as indicated on Drawings.

1. LEDs; 50,000 hours minimum rated life.
2. Self-Powered Exit Signs (Battery Type): Internal emergency power unit

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
 1. Sized and rated for luminaire weight.
 2. Able to maintain luminaire position after cleaning and service.
 3. Provide support for luminaire without causing deflection of ceiling or wall.
 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
- D. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.02 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems".

3.03 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Grounding conductors.
 - 2. Grounding connectors.
 - 3. Grounding busbars.
 - 4. Grounding labeling.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 DEFINITIONS

- A. BCT: Bonding conductor for telecommunications.
- B. TMGB: Telecommunications main ground busbar.
- C. TGB: Telecommunications grounding busbars

1.03 ACTION SUBMITTALS

- A. Product Data: Comply with the requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems".
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.04 INFORMATIONAL SUBMITTALS

- A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:
 - 1. BCT, TMGB, TGBs, and routing of their bonding conductors.
- B. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 2. Field Inspector: Currently registered by BICSI as a designer RCDD to perform the on-site inspection.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.
- C. Comply with TIA-607-B.

2.02 CONDUCTORS

- A. Comply with UL 486A-486B.
- B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.
 - 1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
 - 2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
- C. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B3.
 - 2. Stranded Conductors: ASTM B8.
 - 3. Tinned Conductors: ASTM B33.
 - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 5. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.03 CONNECTORS

- A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.
- B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.
 - 1. Electroplated tinned copper, C and H shaped.
- C. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.
- D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.04 GROUNDING BUSBARS

- A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.
 - 1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.
1. Predrilling shall be with holes for use with lugs specified in this Section.
 2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
 3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.
- C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
 2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
 3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.05 IDENTIFICATION

- A. Comply with requirements for identification products in Section 27 05 53 "Identification for Communications Systems".

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine the AC grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.
- B. Inspect the test results of the ac grounding system measured at the point of BCT connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Bonding shall include the AC utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.
- B. Comply with NECA 1.
- C. Comply with TIA-607-B.

3.03 APPLICATION

- A. Conductors: Install solid conductor for No. 10 AWG and smaller and stranded conductors for No. 8 AWG and larger unless otherwise indicated.
 - 1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
 - 2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.
- D. Conductor Support: Secure grounding and bonding conductors at intervals of not less than 36 inches.
- E. Grounding and Bonding Conductors:
 - 1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
 - 2. Install without splices.
 - 3. Support at not more than 36-inch intervals.
 - 4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.
 - a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Section 27 05 28 "Pathways for Communications Systems", and bond both ends of the conduit to a TGB.

3.04 GROUNDING ELECTRODE SYSTEM

- A. The BCT between the TMGB and the AC service equipment ground shall not be smaller than No. 2/0 AWG.

3.05 GROUNDING BUSBARS

- A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor, unless otherwise indicated.
- B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.06 CONNECTIONS

- A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.
- B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

- C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:
 - 1. Use crimping tool and the die specific to the connector.
 - 2. Pretwist the conductor.
 - 3. Apply an antioxidant compound to all bolted and compression connections.
- D. Primary Protector: Bond to the TMGB with insulated bonding conductor.
- E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.
- F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.
- G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.
- H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.
- I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.
- J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.
- K. Access Floors: Bond all metal parts of access floors to the TGB.

3.07 IDENTIFICATION

- A. Labels shall be preprinted or computer-printed type.
 - 1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
 - 2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
 - 3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.08 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

2. Test the bonding connections of the system using an AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.
 - a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.
3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.
 - a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.
- C. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify DEPARTMENT's Representative promptly and include recommendations to reduce ground resistance.
- D. Grounding system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Hooks.
 - 5. Boxes, enclosures, and cabinets.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 ACTION SUBMITTALS

- A. Product data for each type of product.
- B. Shop Drawings: Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".

1.03 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale and coordinated with each other, using input from installers of items involved.
- B. Seismic Qualification Data: Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".

PART 2 - PRODUCTS

2.01 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 - 2. Comply with TIA-569-D.
 - 3. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".

2.02 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 2. Comply with TIA-569-D.

3. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".

2.03 METAL WIREWAYS AND AUXILIARY GUTTERS

A. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.
3. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".

2.04 HOOKS

A. General Requirements for Hooks:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.
3. Galvanized steel.
4. J shape.

2.05 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".
3. Minimum size 4-11/16" square.

PART 3 - EXECUTION

3.01 PATHWAY APPLICATION

- A. Comply with requirements in Section 26 05 33 "Raceways and Boxes for Electrical Systems".
- B. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.02 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
 1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101.
 5. NECA 102.
 6. NECA 105.
 7. NECA 111.

- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 07 84 00 "Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes.
- F. Complete pathway installation before starting conductor installation.
- G. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- H. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- I. Support conduit within 36 inches of enclosures to which attached.
- J. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 - 3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- K. Stub-Ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- L. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- M. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- N. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- O. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface

pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

- P. Pathways for Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
- Q. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- R. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- S. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- T. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- U. Hooks:
1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.

2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
 3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
 4. Space hooks no more than 5 feet on center.
 5. Provide a hook at each change in direction.
 6. Hooks may be used only in areas with accessible ceiling tiles and not open areas.
- V. Mount boxes at heights indicated on Drawings. Install boxes with height measured to center of box unless otherwise indicated.
- W. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- X. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.03 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 00 "Firestopping".

3.04 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

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SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for labels and signs.
 - 2. Labels.
 - 3. Signs.
 - 4. Cable ties.
 - 5. Fasteners for labels and signs.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Identification Schedule:
 - 1. Outlets: Scaled drawings indicating location and proposed designation.
 - 2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70 and TIA 606-B.
- B. Comply with ANSI Z535.4 for safety signs and labels.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 COLOR AND LEGEND REQUIREMENTS

- A. Equipment Identification Labels: Black letters on a white field.

2.03 LABELS

- A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

- B. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible labels with acrylic pressure-sensitive adhesive.
 - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
- C. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil- thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
 - 1. Minimum Nominal Size:
 - a. 1-1/2 by 6 inches for raceway and conductors.
 - b. 3-1/2 by 5 inches for equipment.
 - c. As required by authorities having jurisdiction.

2.04 SIGNS

- A. Baked-Enamel Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inches.
- B. Laminated-Acrylic or Melamine-Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. in., minimum 1/16 inch thick.
 - b. For signs larger than 20 sq. in., 1/8 inch thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.05 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 12,000 psi.
 - 3. Temperature Range: Minus 40 to plus 185 deg F.
 - 4. Color: Black.

- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
 - 1. Minimum Width: 3/16 inch.
 - 2. Tensile Strength at 73 deg F according to ASTM D638: 7000 psi.
 - 3. UL 94 Flame Rating: 94V-0.
 - 4. Temperature Range: Minus 50 to plus 284 deg F.
 - 5. Color: Black.

2.06 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Verify identity of each item before installing identification products.
- C. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- D. Apply identification devices to surfaces that require finish after completing finish work.
- E. Install signs with approved legend to facilitate proper identification, operation, and maintenance of communications systems and connected items.
- F. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- G. Vinyl Wraparound Labels:
 - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
 - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
 - 3. Provide label 6 inches from cable end.
- H. Snap-Around Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- I. Self-Adhesive Wraparound Labels:
 - 1. Secure tight to surface at a location with high visibility and accessibility.
 - 2. Provide label 6 inches from cable end.
- J. Self-Adhesive Labels:
 - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
- K. Cable Ties: General purpose, except as listed below:
1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.

3.02 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations with high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with paint; the raceways shall be identified with a 6-inch band of paint at 10-foot maximum intervals.
1. Color coding shall be as follows:
 - a. Telecommunications - Blue.
- D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, composed of the following, in the order listed:
1. Wiring closet designation.
 2. Colon.
 3. Faceplate number.
- E. Equipment Room Labeling:
1. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:
 - a. Room number being served.
 - b. Colon.
 - c. Faceplate number.
- F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.
- G. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:
1. Room number.
 2. Colon.
 3. Faceplate number.
- H. Instructional Signs: Self-adhesive labels.

- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Self-adhesive labels.
 - 1. Apply to exterior of door, cover, or other access.
- J. Equipment Identification Labels:
 - 1. Indoor Equipment: Laminated-acrylic or melamine-plastic sign.
 - 2. Outdoor Equipment: Laminated-acrylic or melamine-plastic sign.

END OF SECTION

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SECTION 27 11 00
COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Telecommunications mounting elements.
 - 2. Backboards.
 - 3. Telecommunications equipment frames.
 - 4. Grounding.
- B. Related Requirements:
 - 1. Section 27 15 13 "Communications Copper Horizontal Cabling" for voice and data cabling associated with system panels and devices.

1.03 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. LAN: Local area network.
- C. RCDD: Registered Communications Distribution Designer.
- D. Network Interface Device (NID): Equipment provided by telecom utility, typically on or inside a building, that is the demarcation point between utility and the customer.

1.04 ACTION SUBMITTALS

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

1.05 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Certificates: For equipment frames from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment frames shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

2.02 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 10 00 "Rough Carpentry".

2.03 EQUIPMENT FRAMES

- A. General Frame Requirements:
 - 1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
 - 2. Module Dimension: Width compatible with EIA 310-D standard, 19-inch panel mounting.
 - 3. Finish: Manufacturer's standard, baked-polyester powder coat.
- B. Floor-Mounted Racks: Modular-type, steel construction, 84 inches high, with a channel depth of 3 inches.
 - 1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
 - 2. Baked-polyester powder coat finish, flat black.
 - 3. Two post rack.
- C. Cable Management for Equipment Frames:
 - 1. Metal, with integral wire retaining fingers.
 - 2. Baked-polyester powder coat finish.
 - 3. Vertical cable management panels shall have front and rear channels, with covers.
 - 4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.04 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting.
 - 3. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.

4. LED indicator lights for power and protection status.
5. LED indicator lights for reverse polarity and open outlet ground.
6. Cord connected with 15-foot line cord.
7. Rocker-type on-off switch, illuminated when in on position.
8. Peak Single-Impulse Surge Current Rating: 26 kA per phase.
9. Protection modes shall be line to neutral, line to ground, and neutral to ground. UL 1449 clamping voltage for all three modes shall be not more than 330 V.

2.05 GROUNDING

- A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Telecommunications Main Bus Bar: Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems".
- C. Comply with J-STD-607-A.

2.06 LABELING

- A. Comply with requirements in Section 27 05 33 "Identification for Communications Systems".
- B. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.
- C. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- D. Coordinate layout and installation of communications equipment with DEPARTMENT's telecommunications and LAN equipment and service suppliers.
 1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and DEPARTMENT to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute them to other participants.
 3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
 4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.
- E. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

3.02 BACKBOARDS

- A. Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.03 FIRESTOPPING

- A. Comply with requirements in Section 07 84 00 "Firestopping".
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.04 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.
 - 1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.05 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Section 27 05 53 "Identification for Communications Systems".
- B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.
- D. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 27 15 13
COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Grounding provisions for twisted pair cable.
- B. Related Requirements:
 - 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. Horizontal cabling shall contain no transition or consolidation points between the horizontal cross-connect and the telecommunications equipment outlet.
 - 2. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.03 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by DEPARTMENT.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration Drawings and printouts.
 - 4. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment.
- C. Twisted pair cable testing plan.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For RCDD, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.

- D. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.
 - 2. Program Software Backup: On USB media.
 - 3. Device address list.
 - 4. Printout of software application and graphic screens.
- C. Record plans with all outlets, terminations labeled. Copy of approved document shall be placed in envelope and posted on or adjacent to equipment rack.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and cabling administration Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
 - 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.07 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with DEPARTMENT's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.
- C. Grounding: Comply with TIA-607-B.

2.02 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated: Type CMP complying with UL 1685
 - 2. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
 - 3. Communications, Non-plenum: Type CMR complying with UL 1666.

4. Communications, Non-plenum: Type CMP or Type CMR in listed plenum or riser communications raceway.
 5. Communications, Non-plenum: Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. RoHS compliant.

2.03 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Shielded twisted pairs (FTP).
- E. Cable Rating: Plenum.
- F. Jacket: Blue thermoplastic.

2.04 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
1. Comply with the performance requirements of Category 6.
 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- D. Connecting Blocks:
1. 110-style IDC for Category 6.
 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
 2. Standard: Comply with TIA-568-C.2.
 3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

H. Faceplate:

1. Two port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices".
3. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

I. Wall-mounted phone faceplate:

1. One port, vertical, designed to support a wall mounted phone.
2. Stainless steel.

J. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.05 GROUNDING

- A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with TIA-607-B.

PART 3 - EXECUTION

3.01 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.
- B. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters. Conceal raceway and cables, except in unfinished spaces.
1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Comply with requirements for raceways and boxes specified in Section 27 05 28 "Pathways for Communications Systems".
- C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.
- D. General Requirements for Cabling:
1. Comply with TIA-568-C.1.
 2. Comply with BICSI's Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

3. Install 110-style IDC termination hardware unless otherwise indicated.
 4. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
 5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.
 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 11. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
 12. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources: Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

3.02 FIRESTOPPING

- A. Comply with requirements in Section 07 84 00 "Firestopping".
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.03 GROUNDING

- A. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems".

3.04 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 27 05 53 "Identification for Communications Systems".
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.
- C. Equipment grounding conductors.

- D. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet.
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.05 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
- C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

SECTION 31 00 00 - EARTHWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract apply to work of this section.
- B. Alaska Department of Transportation and Public Facilities (ADOT&PF) Standard Specifications for Highway Construction, 2015 Edition, to the extent referenced.
- C. Related Sections:
 - 1. Section 01 57 20 – Erosion, Sediment, and Pollution Control.
 - 2. Section 31 22 13 - Rough Grading.
 - 3. Section 31 23 16 - Excavation.
 - 4. Section 31 23 17 – Trenching.
 - 5. Section 31 23 23 - Fill.
 - 6. Section 32 11 23 – Aggregate Base Course.
 - 7. Section 32 15 00 – Aggregate Surface Course.

1.02 SUMMARY

- A. Section Description:
 - 1. Soil Materials for site work. Aggregate surface course material is in Section 32 15 00 AGGREGATE SURFACE COURSE.
 - 2. The Owner provides ADOT&PF driveway application permit plan review and approval.
- B. Contractor-provided independent test laboratory/Testing Agency for all soil gradation test requirements. Testing services shall include all equipment, labor, materials, and testing plan.
- C. See Specification Section 01 57 20 EROSION, SEDIMENT, AND POLLUTION CONTROL, Paragraph Submittals, for the SWPPP associated with CONTRACTOR site work.

1.03 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T96 - Test for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
- B. ASTM International:
 - 1. ASTM C117 - Materials Finer than 75-Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
 - 2. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.
 - 3. ASTM D75 - Sampling Aggregates.
 - 4. ASTM D422 - Particle-Size Analysis of Soils.
 - 5. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
- C. Alaska Test Method (ATM):
 - 1. ATM 207 – Moisture Density Relations of Soil.
 - 2. ATM 204 – Determining Liquid Limit of Soils.
 - 3. ATM 205 – Determining Plastic Limit and Plasticity Index of Soils.
 - 4. ATM 212 – Determining the Standard Density of Coarse Granular Materials Using the Vibratory Compactor.

5. ATM 304 – Sieve Analysis of Fine and Coarse Aggregates.
6. ATM 313 – Degradation Value of Aggregate.

1.04 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Laboratory Tests: For all soil used as fill and backfill.
 1. ATM 304 soil gradations and, ATM 207 and ATM 212 optimum moisture-maximum density curve for each Soil Material used.
- C. Material Source: Submit name of imported materials source.
- D. Manufacturer's Certificate: Certify products meet or exceed requirements.

1.05 QUALITY ASSURANCE

- A. Furnish each soil material from single source throughout the Work. If the source changes, then provide a new set of material submittals per Article SUBMITTALS.

1.06 DEFINITIONS

- A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.
- B. Non-Frost-Susceptible (NFS) soils are inorganic soils containing 5 percent or less by weight grains finer than Sieve No 200.
 1. Test Method: ASTM C117, C136, D75, and D422.
- C. Fill is material placed above the existing surface.
- D. Backfill is material placed in an excavation.
- E. Bedding is material in which buried pipes, cables, and utility appurtenances are set.
- F. Unsuitable soil is in-place soil or other material that can be identified as having insufficient strength characteristics or unsuitable to carry intended loads without excessive consolidation or loss of stability. Materials which do not comply with the requirements for soil materials are unsuitable. Materials classified in ASTM D2487 as PT, OH, or OL are unsuitable. Unsuitable materials also include refuse or uncompacted backfills from previous construction.
- G. Compaction is by tamping soil with a hand tool or machine to achieve a specific in-place density.
- H. Unstable subgrade includes pockets of soft, yielding soil identified during subgrade compaction and soil identified by subgrade inspection.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Soil Materials - Soil material used for fill and backfill shall be free of debris, roots, wood, scrap material, vegetation, refuse, soft unsound particles, and deleterious or objectionable materials and shall not contain unsuitable material and frozen material. Unless specified otherwise, the maximum particle diameter shall be one-half the lift thickness at the intended location. Soil materials include Structural, Subbase, Granular, General Fill, and Bedding.

- B. Subbase - Subbase soil material shall be NFS gravel, as produced from approved sources. It shall consist of crushed or naturally occurring granular material, which provides a uniform mixture complying with the requirements of these specifications, as to gradation, soil constants, and capability of being compacted into a dense and stable structure. The material shall be free of vegetable matter, trash, snow and ice, lumps, or excessive amounts of silt, clay and other objectionable foreign substances and may be pit-run material that meets the requirements specified in the following tables below consistent with the Alaska Department of Transportation and Public Facilities (ADOT) Standard Specifications for Highway Construction.

Table 1: ADOT Subbase Type B Material Gradation

<u>Sieve Size</u>	<u>% Passing by Weight</u>
2 inch	100
No. 4	15-60
No. 200	*6.0 max. (*Based on that portion passing the 3-inch screen.)

Table 2 : ADOT Subbase Type B Material Properties

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
L.A. Wear %	AASHTO T 96	50, max.
Liquid Limit	ATM 204	25, max.
Plasticity Index	ATM 205	6, max.
Degradation Value	ATM 313	40, min.

- C. Structural Fill - Structural fill shall meet the requirements below as defined by Geotechnical Recommendations Haines Maintenance & Operations Station; Project No. 57183-B Final Rev 1 by Shannon and Wilson dated April 2024:

Table 3. Structural Fill Material Properties	
<u>Size</u>	<u>Percent Passing</u>
3-Inch	100
No. 4 Sieve	30-60
No. 200 Sieve	0-6

- D. Bedding Material: Bedding material shall be gravel or sand and shall not have mechanically fractured material. Pipe bedding shall meet the following gradation as defined by Geotechnical Recommendations Haines Maintenance & Operations Station; Project No. 57183-B Final Rev 1 by Shannon and Wilson dated April 2024. The Contractor shall provide non-frost-susceptible bedding for direct bury cable in accordance with cable manufacturer requirements.

Table 4 : Bedding Material Gradation

<u>U.S. Std. Sieve</u>	<u>Cumulative % Passing by Weight</u>
1-inch	100
No. 200	0-6

2.02 SOURCE QUALITY CONTROL

- A. When tests indicate materials do not meet specified requirements, change material and retest.
- B. Furnish materials of each type from same source throughout the Work. If the source changes, then provide a new set of material submittals per Article SUBMITTALS.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. Excavated material shall be used to the maximum extent possible for Soil Material.
- B. Stockpile excavated material potentially meeting requirements for Soil Material separate from unsuitable soil. Before using excavated soil for fill and backfill, it shall be tested to confirm that it meets requirements set forth in Part 2 PRODUCTS.

3.02 STOCKPILING

- A. Stockpile materials on site at locations coordinated and approved by the OWNER's Representative.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types or contamination.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.

3.03 STOCKPILE CLEANUP

- A. Grade stockpile to prevent free standing surface water. Leave area in clean and neat condition.

3.04 PREPARATION

- A. Underground Utility Locates: Request underground utilities to be located and marked within and surrounding construction areas.
 - 1. Call Alaska Dig Line at (907) 278-3121 for private utility information not less than (1) week before performing Work.
- B. Identify required lines, levels, contours, monuments, and datum.
- C. Notify and coordinate with utility companies to remove and relocate utilities as required.
- D. Protect utilities indicated to remain from damage.
- E. Protect plant life, pavements, roadway surfaces, and other site features remaining as portion of final landscaping.
- F. Protect bench marks, survey control points, existing structures and paving from excavating equipment and vehicular traffic.

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PROJECT NO. Z571830000

SECTION 31 00 00
EARTHWORK

END OF SECTION

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SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Section Includes:
 - 1. Protecting existing vegetation to remain.
 - 2. Clearing and grubbing.
 - 3. Removing above- and below-grade site improvements.
 - 4. Protection of existing structures to remain
- B. Related Sections:
 - 1. Section 01 52 13 – Field Offices and Sheds
 - 2. Section 01 51 00 – Construction Facilities, for temporary construction and support facilities
 - 3. Section 01 57 10 – Erosion Sediment and Pollution Control, for temporary erosion- and sedimentation-control measures.
 - 4. Section 01 72 00 – Utilities Coordination for utility coordination.

1.03 DEFINITIONS

- A. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.04 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled, temporarily relocated, or otherwise to remain DEPARTMENT's property, cleared materials shall become the CONTRACTOR's property and shall be removed from the Project site before final acceptance.

1.05 BUY AMERICAN PREFERENCE

- A. This project must meet Federal-Aid (FAA) Buy American Preference requirements for "Total Facility." Reference Specification Section 00750 Part III and Section 00800 SC-6.5. The intent is for the Bidder to comply with 100% Buy American Preferences of 49 USC 50101(a). Items not meeting 100% Buy

American requirements shall be identified during the bid process to allow the Bidder to prepare a Type 3 or Type 4 Waiver request prior to Contract award.

1.06 SUBMITTALS

- A. Buy American Compliance: All submittals shall include a certification or other evidence that products meet Buy American Preference requirements of the project. This may include evidence that the product was submitted in an approved Type 3 or Type 4 waiver request prior to contract award. Submittals without the certification or other evidence indicating compliance will be rejected without further review.

1.07 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
 - 1. Use sufficiently detailed photographs.
 - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
 - 3. Include work plan to protect existing structures designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.08 DUST AND DEBRIS CONTROL

- A. Prevent the spread of all dust and debris to adjacent streets, roads, and land areas.
- B. Avoid the creation of nuisance or hazard in the surrounding area and adjacent property.
- C. Do not use water if it will result in or create hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution of adjacent property, roads, or streets.
- D. Vacuum adjacent existing pavements as often as necessary to control the spread of dust and debris.

1.09 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations. See Drawings for Demolition Phasing Plan.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the DEPARTMENT.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by the DEPARTMENT.
- B. Utility Locator Service: Notify the Alaska Dig Line for area where Project is located before site clearing.
- C. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.
- D. The following practices are prohibited within protection zones:
 - 1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.
 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- E. Do not direct vehicle or equipment exhaust towards protection zones.
- F. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.
- G. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 00 00 – Earthwork.
1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Protect existing site improvements to remain from damage during construction.
1. Restore damaged improvements to their original condition, as acceptable to the DEPARTMENT.

3.02 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction. SEE SECTION 01 57 10 – EROSION, SEDIMENT AND POLLUTION CONTROL.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.03 EXISTING UTILITIES

- A. Locate, identify, and disconnect utilities indicated to be abandoned in place. Location and protection of existing underground utilities is the responsibility of the CONTRACTOR.

- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by DEPARTMENT or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify DEPARTMENT and DEPARTMENT's field engineer not less than 7 days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without DEPARTMENT's written permission.
- C. Excavate for and remove underground utilities indicated to be removed.

3.04 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.
- C. No on site burning of trees, brush, shrubs, stumps or limbs will be allowed.

3.05 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove chain link fence fabric, concrete footings, post, rails, and connecting hardware.
- C. Remove headbolt heater outlet post.
- D. Remove traffic signs.
- E. Remove loading dock and return to Owner.
- F. The shop is to be removed in accordance with Section 02 41 00 Demolition.

3.06 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off property.

END OF SECTION

SECTION 31 20 01 – DEMOLITION EXCAVATION AND FILL

PART 1 - GENERAL

1.01 SUMMARY

- A. Excavate on site only as necessary to remove improvements as called out on the plans and in other subsections of these specifications, and to terminate utilities. Work includes returning the site to the original (pre-demolition) uniform grade.
- B. No portion of the demolition debris will be used for backfill or left onsite for any other purpose.
- C. Areas of demolition will be cleaned of visible debris and inspected by the Department Representative prior to conducting any excavation or backfill at that location.
- D. Stabilize all disturbed areas resulting from demolition or backfill.

1.02 RELATED SECTIONS

- A. Division 1 Specifications.
- B. Section 01 35 45 – Airborne Contaminant Control.
- C. Section 02 26 00 – Hazardous Materials Assessment.
- D. Section 02 41 00 – Demolition.
- E. Section 02 82 33 – Removal and Disposal of Asbestos Containing Materials.
- F. Section 02 83 33 – Removal and Disposal of Materials Containing Lead.
- G. Section 02 84 18 – Removal and Disposal of Chemical Hazards.
- H. Section 31 00 00 Earthwork
- I. Section 31 23 16 - Excavation.
- J. Section 31 23 23 – Fill.
- K. Section 32 15 00 – Aggregate Surface Course.

1.03 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Laboratory Tests: Soil Material gradations and moisture-density curve are submitted under Specification Section 31 00 00 EARTHWORK. Aggregate Surface Course gradations and moisture-density curve are submitted under Specification Section 32 11 23 AGGREGATE SURFACE COURSE.
- C. Field In-Place Density Testing Results and location of all testing sites.

PART 2 - PRODUCTS

2.01 EXCAVATION

- A. All excavation shall be unclassified excavation, and shall consist of excavation of all materials, of whatever character, encountered in the Work.

2.02 MATERIALS

- A. Soil Materials: As specified in Section 31 00 00, EARTHWORK.
- B. Aggregate Surface Course: As specified in Section 32 11 23 AGGREGATE SURFACE COURSE.

PART 3 - EXECUTION

3.01 EXCAVATION

- A. All soil excavation within project boundaries shall be in accordance with the Soil Management Plan.
- B. Disturbed slopes shall be stabilized if left exposed at the end of a work day.
- C. Excavations shall be protected from erosion and maintained to drain freely at all times.
- D. No soil may be exported off site without the prior approval of the Department's Representative.
- E. The Contractor shall provide added care when excavating adjacent to existing roadways, sidewalks, curbs, utility poles, above ground electrical pedestals, and underground utilities. Damage caused to existing roadways, sidewalks, curbs, utility poles, above ground electrical pedestals, and underground utilities not included in the Work by the Contractor shall be repaired at the Contractor's expense.

3.02 SUBGRADE PREPARATION

- A. Compact subgrade for subsequent backfill materials.
- B. Contractor shall compact the subgrade systematically and uniformly until a suitable base is achieved to allow placement and compaction of subsequent layers of fill material.
- C. Proof-roll the subgrade with a minimum of four passes of a self-propelled vibratory compactor or tamp by excavator bucket until a firm base for the backfill material is obtained.
- D. Add suitable soil material to form a relatively level surface and continue compaction until the subgrade is a suitable base for the placement and compaction of the first lift of fill, as determined by the OWNER's Representative.

3.03 BACKFILL

- A. Backfill as specified in SECTION 31 23 23 FILL and SECTION 32 11 23 AGGREGATE SURFACE COURSE.
- B. Areas outside vehicle traffic areas may be backfilled with General Fill.
- C. Areas within Vehicle traffic areas may be backfilled with General Fill but must be topped with 18" of subbase and 6" of aggregate surface course.

- D. If continued hauling over a completed or partially completed fill causes loss of stability as evident by pumping or rutting, or other damage, the contractor shall repair the damaged grades at their own expense and adjust hauling equipment and procedures so as to avoid further damage.

3.04 FINISHED SURFACE

- E. The finished surface shall be graded to maintain pre-excavation drainage patterns, make gradual grade changes, and prevent the ponding of water.

END OF SECTION

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SECTION 31 22 13 – ROUGH GRADING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Description:
 - 1. Excavation, filling, and back filling for rough grading to top of subbase.
 - 2. Soil compaction density and testing interval requirements.
 - 3. CONTRACTOR provided independent test laboratory/Testing Agency for all soil compaction and soil gradation test requirements. Testing services shall include all equipment, labor, materials, and testing plan.
- B. Related Specification Sections:
 - 1. Section 31 23 16 - Excavation.
 - 2. Section 31 23 23 – Fill.

1.02 REFERENCES

- A. Alaska Test Methods (ATM):
 - 1. ATM 207 – Moisture Density Relations of Soils.
- B. ASTM International:
 - 1. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Pre-Construction Submittal:
 - 1. Field In-Place Density Testing Plan. Provide this submittal under Section 31 23 23, FILL.
- C. Laboratory Tests: Soil Material gradations and moisture-density curve are submitted under Section 31 00 00 EARTHWORK.
- D. Field In-Place Density Testing Results and location of all testing sites.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Project Management and Coordination: Verification of existing conditions before starting work.
- B. Verify survey bench mark and intended elevations for the Work are as indicated on Drawings.

3.02 PREPARATION

- A. Underground Utility Locates: Request underground utilities to be located and marked within and surrounding construction areas.

1. Call Alaska Dig Line at (907) 278-3121 for private utility line information not less than one (1) week before performing Work.
 - B. Identify required lines, levels, contours, monuments, and datum.
 - C. Notify and coordinate with utility companies to remove and relocate utilities as required.
 - D. Protect utilities indicated to remain from damage.
 - E. Protect plant life, pavements, roadway surfaces, and other site features remaining as portion of final landscaping.
 - F. Protect bench marks, survey control point, existing structures and paving from excavating equipment and vehicular traffic.
- 3.03 CONSTRUCTION DURING FREEZING CONDITIONS
- A. See Specification Section 31 23 23 FILL, Construction During Freezing Conditions.
- 3.04 EXCAVATION
- A. CONTRACTOR shall perform all excavation of every description and of whatever substances encountered to the depth indicated on the drawing or otherwise specified.
 - B. See Specification Section 31 23 16 EXCAVATION for stockpiling and Specification Section 31 00 00 EARTHWORK for testing of excavated soil considered for reuse. Gradation testing of excavated soil shall be completed before it is used for project fill and backfill.
 - C. Remove excess excavated soil not intended for reuse, from site.
- 3.05 SUBGRADE PREPARATION
- A. See Specification Section 31 23 23 FILL, Subgrade Preparation.
- 3.06 BACKFILLING
- A. See Specification Section 31 23 23 FILL, Backfilling.
- 3.07 TOLERANCES
- A. Top Surface of Rough Grading: Plus or minus 0.08 foot from required elevation.
- 3.08 FIELD QUALITY CONTROL
- A. Definition: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ATM 207.
 - B. Field in-place density shall be determined in accordance with ASTM D6938. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Project Engineer. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Project Engineer and CONTRACTOR. When tests indicate Work does not meet specified requirements, remove soil lift, replace and retest.

- C. The following table describes minimum soil compaction density and field testing requirements.

Material/Location	Test Method	Number of Tests	*Minimum Compaction Density, ATM 207
General Fill	ASTM D6938	Minimum of 2 tests per lift or 1 test per 8,000 sq. ft., whichever is greater.	95%
Subbase	ASTM D6938	Minimum of 4 tests per lift or 1 test per 4,000 sq. ft., whichever is greater.	95%
*Minimum soil compaction density unless noted otherwise on the Drawings.			

END OF SECTION

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SECTION 31 23 16 – EXCAVATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Description:
 - 1. Excavation for new structures, utilities, and traffic areas.
- B. See Section 02 61 13 for requirements related to the handling of contaminated soils.
- C. Related Specification Sections:
 - 1. Section 01 57 10 – Erosion, Sediment and Pollution Control
 - 2. Section 31 00 00 - Earthwork
 - 3. Section 31 22 13 – Rough Grading.
 - 4. Section 31 23 17 – Trenching.
 - 5. Section 31 23 23 – Fill.

1.02 SUBMITTALS

- A. Sheeting, shoring and bracing plan for excavation.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PREPARATION

- A. Underground Utility Locates: Request underground utilities to be located and marked within and surrounding construction areas.
 - 1. Call Alaska Dig Line at (907) 278-3121 for private utility line information not less than one (1) week before performing Work.
- B. Identify required lines, levels, contours, and datum.
- C. Notify and coordinate with utility companies to remove and relocate utilities.
- D. Protect and support utilities indicated to remain from damage. Any outage shall be coordinated with and approved by the Engineer.
- E. Protect bench marks, survey control points, existing structures, pavements, roadway embankments from excavating equipment and vehicular traffic damage.

3.02 EXCAVATION

- A. Excavations shall be reasonably smooth and uniform to the lines, grades and cross sections shown in the Drawings or as directed by the Owner's Representative. Excavations shall be conducted to ensure that material outside of excavation limits remains undisturbed.
- B. Perform compaction in accordance with Specification Section 31 22 13 ROUGH GRADING.
- C. Slope banks as required to meet Occupational Safety and Health Administration (OSHA) requirements.
- D. Do not interfere with 45-degree bearing splay of foundations.

- E. Grade top perimeter of excavation to prevent surface water from draining into excavation.
- F. Trim excavation. Remove loose matter.
- G. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yards measured by volume.
- H. Notify Owner's Representative of unexpected subsurface conditions.
- I. Correct areas over excavated with subbase fill. See Specification Section 31 00 00 EARTHWORK for soil gradation requirements.
- J. Remove excess and unsuitable material from site.

3.03 EXCAVATED SOIL REUSE

- A. Excavated material shall be used to the maximum extent possible for project fill and backfill. Before use, excavated soil shall be tested to confirm that it meets gradation requirements set forth in Specification Section 31 00 00, EARTHWORK, Part 2 PRODUCTS.

3.04 STOCKPILING

- A. Stockpile materials on site at locations coordinated and approved by the Owner's Representative.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing.
- D. Prevent intermixing of soil types.
- E. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- F. Grade stockpiles to prevent standing surface water.
- G. Leave soil stockpile area in a clean and neat condition.

3.05 SHEETING, SHORING AND BRACING

- A. The Contractor shall sheet, shore, and brace excavations as required to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding soil.
- B. Sheeting and shoring designed to be left in place as part of the completed Work, shall be cut off minimum 36 inches below finished grade.
- C. If sheeting and shoring is used it shall be designed by a registered professional engineer and submitted to the OWNER for approval.

3.06 DEWATERING

- A. Prevent surface water from flowing into excavations and from flooding project site and surrounding area.
- B. Do not allow water to accumulate in excavations. Provide and maintain pumps, sumps, suction, and discharge lines, and other dewatering system components necessary to convey water away from excavations.

- C. Establish and maintain temporary drainage ditches, and other diversions outside excavation limits, to convey rainwater, and water removed from excavations, to collecting or runoff areas. Do not use trench excavations as temporary drainage ditches.
- D. Dewatering activity shall be in accordance with State of Alaska, Alaska Pollution Discharge Elimination System (APDES), General Permit for Excavation Dewatering that will be obtained by the Contractor for this project.

3.07 FIELD QUALITY CONTROL

- A. See Specification Section 31 22 13 ROUGH GRADING for soil compaction testing requirements. See Specification Section 31 00 00 EARTHWORK for soil gradation requirements.
- B. Request visual inspection of subgrade bearing surfaces by Project Engineer before installing subsequent work.

3.08 PROTECTION

- A. Prevent displacement or loose soil from falling into excavation; maintain soil stability.
- B. Protect bottom of excavations and soil adjacent to and beneath foundation from freezing.
- C. Protect and support structures, utilities and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

END OF SECTION

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SECTION 31 23 17- TRENCHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Description:
 - 1. Utility trench backfilling and compaction.
- B. Contractor-provided independent test laboratory/Testing Agency for all soil compaction and soil gradation test requirements. Testing services shall include all equipment, labor, materials, and testing plan.
- C. See Section 02 61 13 for requirements related to the handling of contaminated soils.
- D. Related Sections:
 - 1. Section 01 57 20 – Erosion, Sediment, and Pollution Control.
 - 2. Section 31 00 00 – Earthwork.
 - 3. Section 31 22 13 - Rough Grading.
 - 4. Section 31 23 16 – Excavation.
 - 5. Section 31 23 23 – Fill.

1.02 REFERENCES

- A. Alaska Test Methods (ATM):
 - 1. ATM 207 – Moisture Density Relations of Soils.
- B. ASTM International:
 - 1. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.

1.04 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Pre- Construction Submittal:
 - 1. Field In-Place Density Testing Plan. Provide this submittal under Section 31 23 23, FILL.
 - 2. Traffic Control Plan for Utility Installation Work.
- C. Laboratory Tests: Soil Material gradations and moisture-density curve are submitted under Specification Section 31 00 00 EARTHWORK.
- D. Field In-Place Density Testing Results and location of all testing sites.

1.05 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.06 COORDINATION

- A. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 - PRODUCTS

2.01 FILL MATERIALS

- A. Soil Materials: As specified in Specification Section 31 00 00, EARTHWORK.
- B. Bedding Material: As specified in Specification Section 31 00 00, EARTHWORK.

PART 3 - EXECUTION

3.01 LINES AND GRADES

- A. Lay pipes to lines and grades indicated on Drawings.
 - 1. The OWNER's Representative reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.
- B. Maintain grade and alignment of pipe, cable, or conduit as shown on the Drawings or determined through coordination with the utility owner.

3.02 PREPARATION

- A. Call Local Utility Line Information service not less than three (3) 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 locations.
- C. Protect plant life, and other site features remaining as portion of final surfacing.
- D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities indicated to remain.
- F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work. The Contractor shall provide a traffic control plan for approval prior to beginning Work.

3.03 CONSTRUCTION DURING FREEZING CONDITIONS

- A. See Specification Section 31 23 23 FILL, Construction During Freezing Conditions.

3.04 TRENCHING

- A. The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the Project drawing or as coordinated with the utility owner.
- B. Remove lumped soil, boulders, and rock up of 1/3 cubic yard, measured by volume.

- C. Perform excavation within 24 inches of existing utility service in accordance with utility owner requirements.
- D. Do not advance open trench more than 200 feet ahead of installed pipe, cable, or conduit.
- E. Cut trenches to width and depths indicated on Drawings. Remove water or materials that interfere with Work in accordance with the CONTRACTOR's Storm Water Pollution Prevention Plan (SWPPP).
- F. Provide uniform and continuous bearing and support for bedding material, pipe, cable, and conduit.
- G. Do not interfere with 45 degree bearing splay of foundations.
- H. Trench excavation shall conform to all Federal, State, and Local workplace safety regulations.
- I. When subsurface materials at bottom of trench are loose or soft, immediately contact the OWNER's Representative. Coordinate with the Representative to determine extents of additional trench excavation.
- J. Cut soft areas of subgrade not capable of compaction in place. Backfill with structural soil and compact to density equal to or greater than requirements for subsequent fill material. Where subgrade is saturated use a granular fill. Coordinate fill selection with the Project Engineer. See Section 31 00 00 EARTHWORK for soil gradation requirements.
- K. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose soil.
- L. Correct areas over excavated areas with compacted backfill.

3.05 SHEETING, SHORING AND BRACING

- A. The CONTRACTOR shall sheet, shore, and brace excavations as required and as described in Section 31 23 16 EXCAVATION.
- B. Sheet piling and shoring designed to be left in place as part of the completed Work, shall be cut off minimum 36 inches below finished grade.

3.06 BACKFILLING

- A. Backfill trenches to contours and elevations with unfrozen fill materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- C. Place fill material in continuous layers and compact to densities found in Article FIELD QUALITY CONTROL. Place soil material in continuous layers as follows:
 - 1. Soil Materials: Maximum loose lift thickness of 8 inches and 6 inches when hand operated mechanical compactors are used.
 - 2. Upon approval by the OWNER's Representative, loose lift thickness for soil may be increased up to 12 inches where heavy vibratory equipment is used if the Contractor can demonstrate with field tests that compaction is achieved.
 - 3. Aggregate Surface Course: Maximum 6-inch loose lift thickness.

- D. Employ backfill placement and compaction method that does not disturb or damage foundation perimeter drainage, and utilities in trench.
- E. Maintain optimum moisture content of fill materials to attain required compaction density.
- F. Do not leave more than 50 feet of trench open at end of working day.
- G. Protect open trench to prevent danger to the public and Fire Station Operations.

3.07 TOLERANCES

- A. Top surface of rough grading shall be within 0.08 feet of required elevation.

3.08 FIELD QUALITY CONTROL

- A. Definition: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ATM 207.
- B. Field in-place density shall be determined in accordance with ASTM D6938. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the OWNER's Representative. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the OWNER's Representative and Contractor. When tests indicate Work does not meet specified requirements, remove soil lift, replace and retest.
- C. The following table describes minimum soil compaction density and field testing requirements.

Material	Test Method	Number of Tests	Minimum Compaction Density, ATM 207
General Fill	ASTM D6938	Minimum of 2 tests per lift or 1 test per 3,000 sq. ft., whichever is greater.	95%
Structural Fill and Subbase	ASTM D6938	Minimum of 2 per lift, 1 for each additional 1,500 sf	95%
Traffic and ROW Area Utility Trench Backfill	ASTM D6938	Minimum 2 test per lift per 300 feet of trench or minimum of 2 tests, whichever is greater	95%

3.09 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 23 23 – FILL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Description:
 - 1. Backfilling at foundations.
 - 2. Fill under concrete slabs and pavements.
 - 3. Fill for all site earthwork.
- B. Contractor-provided independent test laboratory/Testing Agency for all soil compaction and soil gradation test requirements. Testing services shall include all equipment, labor, materials, and testing plan.
- C. Related Sections:
 - 1. Section 31 00 00 – Earthwork.
 - 2. Section 31 22 13 – Rough Grading.
 - 3. Section 31 23 16 – Excavation.

1.02 REFERENCES

- A. Alaska Test Method (ATM):
 - 1. ATM 207 - Moisture Density Relations of Soil.
- B. ASTM International:
 - 1. ASTM C578 – Specification for Rigid, Cellular Polystyrene Thermal Insulation.
 - 2. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Pre-Construction Submittal:
 - 1. Field In-Place Density Testing Plan. Include soil testing forms for documenting test results, time, and location of test.
- C. Laboratory Tests: Soil Material gradations and moisture-density curve are submitted under Specification Section 31 00 00 EARTHWORK. Aggregate Surface Course gradations and moisture-density curve are submitted under Specification Section 32 11 23 AGGREGATE SURFACE COURSE.
- D. Field In-Place Density Testing Results and location of all testing sites.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Soil Materials: As specified in Section 31 00 00, EARTHWORK.
- B. Aggregate Surface Course: As specified in Section 32 11 23 AGGREGATE SURFACE COURSE.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify foundation formwork has been removed and concrete finishing completed.
- B. Verify structural ability foundation to support loads imposed by fill.

3.02 SUBGRADE PREPARATION

- A. Compact subgrade for subsequent backfill materials.
 - 1. Contractor shall compact the subgrade systematically and uniformly until a suitable base is achieved to allow placement and compaction of subsequent layers of fill material.
 - 2. Proof-roll the subgrade with a minimum of four passes of a self-propelled vibratory compactor.
 - 3. Add suitable soil material to form a relatively level surface and continue compaction until the subgrade is a suitable base for the placement and compaction of the first lift of fill, as determined by the OWNER's Representative.
- B. Cut out soft or saturated areas of subgrade not capable of compaction in place. Backfill with structural fill and compact to density equal to or greater than requirements for subsequent fill material. Coordinate fill selection with the OWNER's Representative. See Section 31 00 00 EARTHWORK for soil gradation requirements.

3.03 CONSTRUCTION DURING FREEZING CONDITIONS

- A. Frost Action Damage Protection: The Contractor shall take adequate precautions to protect foundations and concrete structure from damage due to frost action during freezing conditions.
 - 1. Backfilling: Exterior foundation footings and walls for slab-on-grade structures shall be backfilled to finish grade prior to ambient air temperature falling below 32 deg F.
 - 2. Heating: When ambient air temperatures fall below 32 deg F concrete structure shall be enclosed and heated such that the minimum interior air temperature at all locations is at least 40 deg F. When exterior foundation footings or walls are not backfilled, areas within 5 feet of the footings or walls shall also be enclosed and heated to 40 deg F minimum.
 - 3. Alternatives: The Contractor may request in writing an alternative method for freeze protection by submitting a Heating and Monitoring Plan in writing to the OWNER's Representative for approval.
- B. Earthwork Fill and Backfill:
 - 1. Fill and backfill shall not be placed over snow accumulation or frozen subgrade.
 - 2. Subgrade active layer shall have thawed at least 12 inches.
 - 3. Fill and backfill for all earthwork shall contain absolutely no snow or ice.
 - 4. At time of installation, temperature of soil for all earthwork fill and backfill shall be above freezing.
 - 5. If previously placed fill freezes, either excavate and waste frozen material or allow it to thaw and recompact prior to placement of additional fill.

3.04 BACKFILLING

- A. Backfill areas to contours and elevations with unfrozen materials.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces.
- C. Place material in continuous layers as follows:
 - 1. Structural and Subbase soils: Maximum loose lift thickness of 8 inches and 6 inches when hand operated mechanical compactors are used.

2. Upon approval by the OWNER's Representative, loose lift thickness for only subbase soil may be increased up to 12 inches where heavy vibratory equipment is used if the Contractor can demonstrate with field tests that compaction is achieved.
 3. Aggregate Surface Course: Maximum 6-inch loose lift thickness.
- D. Employ placement method that does not disturb or damage other work.
- E. Maintain optimum moisture content of backfill materials to attain required compaction density.
1. If silty soils are too wet to compact without pumping occurring in the subgrade or soil lift, allow these soils to dry out naturally, till, or otherwise accelerate the natural drying of the wet soils by mechanical means.
- F. Backfill against supported foundation walls. Do not backfill against unsupported foundation walls.
1. Backfill simultaneously on each side of unsupported foundation walls until supports are in place.
- G. Make gradual grade changes. Blend slope into level areas.
- H. If site features and utilities that are to be retained and protected are damaged by excavation or backfilling, repair or replace said items with new materials.
- 3.05 TOLERANCES
- A. Top surface of rough grading fill shall be within 0.08 feet of required elevation.
- B. Soil surface under footings areas shall be within 0.05 feet of required elevation.
- 3.06 FIELD QUALITY CONTROL
- A. Definition: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ATM 207.
- B. Field in-place density shall be determined in accordance with ASTM D6938. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the OWNER's Representative. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the OWNER's Representative and Contractor. When tests indicate Work does not meet specified requirements, remove soil lift, replace and retest.

- C. The following table describes minimum soil compaction density and field testing requirements.

Material	Test Method	Number of Tests	*Minimum Compaction Density, ATM 207
General Fill	ASTM D6938	Minimum of 2 tests per lift or 1 test per 8,000 sq. ft., whichever is greater.	90% - Outside Vehicle Traffic Area 95% - Traffic Area
Structural Fill and Subbase	ASTM D6938	Minimum of 2 per lift, 1 for each additional 1,500 sf	95%
Traffic and ROW Area Utility Trench Backfill	ASTM D6938	Minimum 2 test per lift per 300 feet of trench or minimum of 2 tests, whichever is greater.	95%
*Minimum soil compaction density unless noted otherwise on the Drawings.			

3.07 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic or other activity that deforms the fill surface.

END OF SECTION

SECTION 31 32 19 – GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 SUMMARY

- A. The WORK under this Section includes providing all labor, material, tools, and equipment necessary for furnishing and installing filter cloth in accordance with the Drawings, or as directed by the ENGINEER
- B. Related Sections:
 - 1. Section 31 00 00 – Earthwork.
 - 2. Section 31 22 13 – Rough Grading.
 - 3. Section 31 23 16 – Excavation.
 - 4. Section 31 23 23 – Fill

1.02 SUBMITTALS

- A. Geotextile fabric product information.

PART 2 - PRODUCTS

2.01 Geotextile Separation Fabric

- A. The geotextile separation fabric is to conform to the requirements of the American Association for State Highway and Transportation Officials (AASHTO) M288-00 for a Class 2 geotextile with an elongation greater than or equal to 50 percent. The Class 2 geotextile should conform to the requirements of Table 3 Separation Geotextile Property Requirements in AASHTO M 288, except the minimum permittivity of the fabric should be 0.05 per second. The geotextile separator should also have an apparent opening size equal to or between the No. 70 and No. 100 U.S. Standard Sieve as determined by ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile. Class 2 geotextile may be joined either by sewing or by overlapping. If the material is joined by overlapping, the material should be overlapped a minimum of 24 inches. The installation of the geotextile fabric should conform to the requirements of Appendix A3 of AASHTO M288.

2.02 Geotextile Reinforcement

- A. The geotextile reinforcement is to meet the requirements of DOT&PF 2020 Standard Specifications Table 729-1, Type 1. Reinforcement geotextile shall meet the survivability requirements presented in Table 729-2, and the physical requirements shown in Table 729-3. The tables are provided below, for reference:

Table 1. DOT&PF Table 729-1			
Property	Test Method	Units	Type 1 Requirement^a
Grab Tensile	ASTM D4632	lb	200/200
Grab Elongation	ASTM D4632	% (MD)	10
Wide Width Tensile	ASTM D4595	lb/in (ultimate)	200/200
Wide Width Tensile	ASTM D5495	lb/in (@ 5% strain)	100/100

Seam Breaking Strength	ASTM D4632	lb/in	180
Puncture	ASTM D6241	lb	500
Trapezoidal Tear	ASTM D4533	lb	100
AOS	ASTM D4751	U.S. sieve size	#30 ^b
Permittivity	ASTM D4491	Sec ⁻¹	0.20
Flow Rate	ASTM D4491	Gal/min/ft ²	10

Notes:

- a. Minimum Average Roll Values (MARV) in machine direction (MD) / cross-machine direction (XD) unless otherwise specified.
- b. Maximum average roll value.

Table 2. DOT&PF Table 729-2			
Property	Test Method	Units	Type 1 Requirement
Ultimate Multi-Rib Tensile Strength ^a	ASTM D6637	lb/fit	1230
Junction Strength ^a	ASTM D7737	lb	25
Ultraviolet Stability (Retained Strength)	ASTM D4335	%	50% after 500 hours of exposure

Notes:

- a. Minimum Average Roll Values (MARV) in any rib direction.

2.03 SEAMS

- A. Seams, where required, shall be sewn with thread of material meeting the chemical requirements given above for plastic yarn. The sheets for filter cloth shall be sewn together at the factory or another approved location to form sections not less than two feet wide. Seams shall be tested in accordance with ASTM D 1682, using one inch square jaws and 12 inches per minute constant rate of traverse. The strengths shall be not less than 90 pounds in any principal direction.

2.04 ACCEPTANCE REQUIREMENT

- A. All brands of plastic filter cloth and all seams to be used will be accepted on the basis of a certification. The CONTRACTOR shall furnish the ENGINEER a mill certificate or affidavit signed by a legally authorized official from the company manufacturing the cloth. The mill certificate or affidavit shall attest that the cloth meets the chemical, physical, and manufacturing requirements stated in this Section.

2.05 SHIPMENT AND STORAGE

- A. During all periods of shipment and storage, the cloth shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140° F, mud, dirt, dust, and debris. To the extent possible, the cloth shall be wrapped in a heavy-duty protective covering.

PART 3 - EXECUTION

3.01 CONSTRUCTION

- A. Geotextile separation fabric shall be placed in the manner and at the locations shown on the Drawings or as directed by the ENGINEER. At the time of installation, the fabric shall be rejected if it has defects, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage.
- B. The surface upon which the geotextile separation fabric is to be placed shall be free of projections or depressions, and rocks, roots, and other sharp objects which may cause the filter cloth to be punctured. The fabric shall be placed without stretching and shall lie smoothly in contact with the soil surface. When overlapping of strips is necessary, the joints shall be overlapped a minimum of two feet. End overlaps shall be made in the direction of flow.
- C. The geotextile separation fabric shall be protected at all times during construction from contamination or from damage during its installation or during placement of subsequent covering; contaminated or damaged cloth shall be replaced at the CONTRACTOR's expense, or if the ENGINEER permits, torn fabric may be patched. The aggregate material shall be cleaned from the fabric, and the torn area shall be overlain with fabric with a minimum three foot overlap around the edges of the torn area. Care shall be taken that the patch remains in place when material is placed over the affected area.
- D. The WORK shall be scheduled so that not more than 30 Days elapse between the placement of the fabric and the time it is covered with specified material.
- E. Following placement of the fabric on the prepared surface, material of the type shown on the Drawings shall be back-dumped on the previously spread fabric or ground adjacent to the fabric and carefully pushed or spread onto the fabric by a dozer or other machinery. A minimum depth of one foot, or the depth shown on the Drawings, shall be maintained at all times between the fabric and the wheels or tracks of the construction equipment. At no time shall equipment operate on the unprotected fabric. The material shall be spread in the direction of the fabric overlap. Special care shall be taken to maintain a proper overlap and fabric continuity.

END OF SECTION

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SECTION 32 11 23 - AGGREGATE BASE COURSE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Gradation and installation requirements for Aggregate Base Course.
- B. CONTRACTOR-provided independent test laboratory/Testing Agency for all soil gradation test requirements. Testing services shall include all equipment, labor, materials, and testing plan.
- C. Related Sections:
 - 1. Section 01 57 10 – Erosion, Sediment and Pollution Control
 - 2. Section 31 00 00 – Earthwork

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials:
 - 1. AASHTO T 96 - Test for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 2. AASHTO T 180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- B. ASTM International:
 - 1. ASTM D 1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 - 2. ASTM D 1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - 3. ASTM D 2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - 4. ASTM D 6938 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 5. ASTM D 3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
- C. Specific technical portions of State of Alaska Department of Transportation and Public Facilities (ADOT&PF), Standard Specifications for Highway Construction, 2004 Edition, as referenced in Division 2 Section "Aggregate Base Course."
- D. Alaska Test Method (ATM):
 - 1. ATM 313 – Degradation Value of Aggregate.
- E. Western Alliance for Quality in Transportation Construction Field Operating Procedures (WAQTCFOP):
 - 1. WAQTCFOP for AASHTO T 89 - Liquid Limit of Soils.
 - 2. WAQTCFOP for AASHTO T 90 - Plastic Limit for Plasticity Index of Soils.

1.03 SUBMITTALS

- A. Division 1 Section "Submittal Procedures": Requirements for submittals.
- B. Product Data: Submit data for all products in Part 2 PRODUCTS used for Project Work.
- C. Soil gradations and ASTM D 1557 optimum moisture-maximum density curve for each type of soil in Part 2 PRODUCTS used for project work.
- D. Materials Source: Submit name of aggregate materials suppliers.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.

PART 2 - PRODUCTS

2.01 SOIL MATERIALS

- A. Aggregate Base Course: Aggregate Base Course shall meet the D-1 requirements of Alaska Department of Transportation and Public Facilities (ADOT&PF) Standard Specifications for Highway Construction, 2004 Edition, Table 703-2, Aggregate for Base and Surface Course. The following is ADOT&PF D-1 soil gradation.

U.S. Standard Sieve	Cumulative % Passing by Weight
1"	100
3/4"	70-100
3/8"	50-80
#4	35-65
#8	20-50
#50	6-30
#200	0-6

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify compacted substrate is dry and ready to support imposed loads.
 - 1. Proof roll subbase with heavy vibratory roller compactor in minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft substrate and replace with compacted subbase fill as specified in Division 2 Section "Fill."
- B. Verify substrate has been inspected, gradients and elevations are correct.

3.02 PREPARATION

- A. Correct irregularities in subbase gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.

3.03 CONSTRUCTION DURING FREEZING CONDITIONS

A. Earthwork Fill and Backfill:

1. Fill and backfill shall not be placed over snow accumulation or frozen subgrade or subbase.
2. Fill and backfill for all earthwork shall contain absolutely no snow or ice.
3. At time of installation, temperature of soil for all earthwork fill and backfill shall be above freezing.

3.04 SOIL PLACEMENT

A. Place soil in continuous layers as follows:

1. Aggregate Base Course: Maximum 6-inch loose lift thickness.

3.05 TOLERANCES

- A. Top surface of substrate shall be within 0.08 feet of required elevation
- B. Top surface of aggregate base and surface course shall be within 0.05 feet of required elevation.

3.06 FIELD QUALITY CONTROL

- A. Definition: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in AASHTO T 180.
- B. Density Testing:
1. Field in-place density shall be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 6938. When ASTM D 6938 is used, the calibration curves shall be checked and adjusted using the sand cone method as described in paragraph Calibration of this ASTM publication. ASTM D 6938 results in a wet unit weight of soil and when using this method, ASTM D 3017 shall be used to determine the moisture content of the soil. The calibration curves furnished with the moisture gauges shall be checked along with density calibration checks as described in ASTM D 3017.
 2. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the DEPARTMENT's Representative. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the DEPARTMENT's Representative. When tests indicate Work does not meet specified requirements, remove soil lift, replace and retest.
- C. Minimum Soil Compaction Density and Field Testing Requirements:

Material/Location	Test Method	Number of Tests	Minimum Compaction Density, ASTM D 1557
Aggregate Base Course/ Roadway Crossing, Slab on Grade	ASTM D 6938	Minimum of 2 per lift, 1 for each additional 1,500 sq. ft.	98%

END OF SECTION

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SECTION 32 12 16 – HOT MIX AC PAVING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. WORK consists of the furnishing and mixing of aggregate, asphalt cement, and additives at a mixing plant and the hauling, spreading, and compaction of the asphalt concrete mixture on a previously prepared surface, all as specified in the contract and in conformance with the lines, grades and thicknesses shown on the Drawing.
- B. Asphaltic concrete mix for this project shall be Type II-A, Class B. See Table 32 12 16-1 and Table 32 12 16-2.

TABLE 32 12 16-1

ASPHALTIC CONCRETE MIX REQUIREMENTS		
DESIGN PARAMETERS	CLASS A	CLASS B
Stability, lbs.	1,800	1,800
Flow, 0.01 inch (0.25 mm)	8-14	8-14
Voids in total mix, percent	2.5-4.5	2.5-4.5
Compactions, number of blows each side of test specimen	75	50
Dust-asphalt ratio (1)	0.6-1.0	0.6-1.0
Percent oil content	5.8-6.8	5.8-6.8
Voids in the mineral aggregate (VMA) Minimum value		
Type I	13.0	12.0
Type II or IIA	14.0	13.0
Type III	15.0	14.0

(1) Dust-asphalt ratio is defined as the percent of material passing the U.S. No. 200 sieve divided by the percent of asphalt (calculated by weight of mix).

PART 2 - PRODUCTS

2.01 COMPOSITION OF ASPHALT CONCRETE MIXTURES - JOB MIX DESIGN

- A. Asphalt concrete mixtures shall be composed of aggregate, asphalt cement, and required additives combined within the limits for the type and class specified in the contracts.
- B. It is the CONTRACTOR's responsibility to ensure that, in addition to the aggregate gradation requirements, the aggregate material meets all the requirements of this Section and asphalt concrete mixture meets the applicable design parameters, when tested according to ATM T-17.
- C. At least 15 days prior to the production of asphalt concrete pavement the CONTRACTOR shall submit a current mix design. The mix design shall be performed within six (6) months of the construction season. The following related items shall be submitted with the mix design:
1. Notification that aggregate proposed for the asphalt concrete mixture is available for sampling.

2. A letter stating the proposed gradation for the Trial Job Mix Design, gradations for individual stockpiles, and blend ratio for each aggregate stockpile.
 3. A minimum of three (3) one-gallon samples of the asphalt cement proposed for use in the mixture, including name of product, manufacturer, test results as required, manufacturer's certificate of compliance, and a temperature viscosity curve for the asphalt cement.
 4. A 1/2 pint sample of the anti-strip additive proposed, including name of product, manufacturer, and manufacturer's data sheet, and current Materials Safety Data Sheet (MSDS).
 5. The CONTRACTOR shall accompany the OWNER'S REPRESENTATIVE during sampling, and shall furnish all the assistance needed to ensure that the OWNER'S REPRESENTATIVE obtains representative samples.
 6. The mix design shall be a 50 blow Marshall Method.
- D. The OWNER'S REPRESENTATIVE will evaluate the gradation for the Trial Job Mix Design and suitability of the materials submitted. If the asphalt concrete mixture conforms to the design parameters specified in Table 32 12 16-1 when tested according to ATM T-17, the OWNER'S REPRESENTATIVE will approve the Trial Job Mix Design and specify a target value for the asphalt cement content, mixing temperature and additives.
- E. If the Trial Job Mix Design does not conform to the design parameters specified in Table 32 12 16-1, when tested by the OWNER'S REPRESENTATIVE, the CONTRACTOR shall submit in writing to the OWNER'S REPRESENTATIVE another proposed gradation for a second Trial Job Mix Design. Samples of aggregate and additional asphalt cement shall be obtained in the same manner as for the original Trial Job Mix Design. The OWNER'S REPRESENTATIVE shall evaluate and test the second Trial Job Mix Design and either approve or disapprove the design based on the contract requirements. The above procedure shall be repeated until the Trial Job Mix Design is approved.
- F. If the CONTRACTOR proposes a change in source of aggregate material, source of asphalt cement, or a change in the gradation target values after production has started, the CONTRACTOR shall submit in writing the proposed gradation target values to the OWNER'S REPRESENTATIVE and request a new Trial Job Mix Design be evaluated for approval. The CONTRACTOR shall accompany the OWNER'S REPRESENTATIVE during sampling and shall furnish all assistance needed to assure that the OWNER'S REPRESENTATIVE obtains representative samples. Approval of the new Trial Job Mix Design and/or aggregate material will require testing and evaluation. Trial Job Mix Design test results will be available within 15 calendar days of submittal. If the asphalt concrete mixture conforms to the design parameters specified in Table 02801-1 when tested in accordance with ATM T-17, the OWNER'S REPRESENTATIVE will develop a new target value for the asphalt cement content, mixing temperature and additives. The new target values for gradation and asphalt cement content will only be in effect on asphalt concrete mixture produced after the CONTRACTOR submittal of the new gradation target values for the Trial Job Mix Design.
- G. The location and type of the mixing plant shall be included with the Trial Job Mix Design data. Asphalt concrete mixtures produced from different plants shall not be mixed.
- H. All trial job mix designs as required will be assessed and paid for by the CONTRACTOR.

2.02 ASPHALT AGGREGATES

- A. Aggregate for Plant Mix Asphalt Pavement:
1. Coarse Aggregate: Coarse aggregate (that material retained on the No. 4 sieve) shall be crushed stone and shall consist of sound, tough, durable rock of uniform quality. Rock

shall be free of schist that cleaves along preferred foliation planes. Rock shall be free of platy mineral grains. Metamorphosed rock shall be free of slaty cleavage. All material shall be free from clay balls, vegetable matter or other deleterious matters. Coarse aggregate shall not be coated with dirt or other finely divided mineral matter. All asphalt aggregates shall be free of roots and wood. In addition, coarse aggregate shall meet the following requirements:

Nordic Abrasion Value	Nordic Abrasion Test Procedures ¹	16.0 Max.
Percent of Wear	AASHTO T 96	25 max.
Degradation Value	ATM T-13	30 min.
Percent Sodium Sulfate Loss	AASHTO T 104	10 max.
Percent Fracture	ATM T-4	100 min. single face/ 80 min. double face

2. Asphalt concrete aggregate shall not exceed eight percent thin - elongated pieces as determined by ATM T-9.
3. Fine Aggregate: Fine aggregate (passing the No. 4 sieve) shall meet the quality requirements of AASHTO M 29. Fine aggregate angularity shall be 40 minimum as determined by AASHTO T 304.
4. The several aggregate fractions for the mixture shall be sized, graded, and combined in such proportions that the resulting composite blend conforms to the grading requirements of Table 02801-2. Aggregates gradations shall be determined by ATM T-7, except when the sample is obtained by extraction.
5. Asphalt aggregate may be a blend but shall be 80% mechanically crushed with no more than 20% natural sand.
6. The material furnished shall conform to the approved Job Mix Design within the tolerances specified, except the limits given in Table 02801-2 may not be exceeded.

<u>Sieve Size</u>	<u>Tolerance % Passing</u>
¾ inch	100
½ inch	± 6
3/8 inch	± 6
No. 4	± 6
No. 8	± 6
No. 16	± 5
No. 30	± 4
No. 50	± 4
No. 100	± 3
No. 200	± 1

¹ Nordic Abrasion Test Procedures will apply to both the coarse and intermediate aggregate for asphalt aggregate. Test procedures for Nordic Abrasion are available at AKDOT&PF SE Region Materials Laboratory.

TABLE 32 12 16-2

ASPHALT CONCRETE AGGREGATE Percent Passing by Weight				
Sieve Design	Type I	Type II	Type II-A	Type III
1-inch	100			
3/4 inch	80-95	100	100	
1/2 inch	60-88	80-95	86-98	100
3/8 inch	48-77	60-87	74-86	80-95
No. 4	28-63	36-48	46-58	44-81
No. 8	14-55	19-35	29-41	26-70
No. 16	9-46	10-25	18-28	16-59
No. 30	6-39	7-21	11-19	9-49
No. 50	5-29	5-20	6-14	6-36
No. 100	4-18	4-15	3-9	4-22
No. 200	2-6	2-6	2-6	2-6

2.03 ASPHALT MATERIALS

- A. "The grade of asphalt cement material will be PG 58-22. The asphalt cement material shall conform to the applicable requirements of this Section and will be conditionally accepted at the source. If the material is to be conditionally accepted at the source, the CONTRACTOR shall provide a manufacture's certificate of compliance in accordance with this section and test results of the applicable quality requirements of this Section before the material is shipped. If there is a change in the source of the asphalt cement or if the kinematic viscosity (viscosity at 275°F) of the asphalt supplied for the Trial Job Mix Design by a factor of two (doubles or halves) or more, then operations shall be suspended while a new Trial Job Mix Design proposal is submitted for approval.

B. ASPHALT CEMENT

1. Asphalt cement shall be designated PG58-28 Plus.

C. CUT-BACK ASPHALTS

1. Cut-back asphalts shall conform to the requirements of AASHTO M 81 and M 82 except as follows:
 - a. In Table 1 of M 82, reduce the minimum absolute viscosity on residue from distillation at 60°C to 100, in the MC-30 and MC-250 columns, and revise the maximum distillate percentage by volume of total distillate at 225°C for MC-30 to read: 35%.

TEST FOR	SPECIFICATIONS	AASHTO TEST METHOD	SPECIFICATIONS
Penetration	(4°C [39.2°F], 200g, 60s), dmm RTFO Aged Residue <u>Note 1</u>	T 49	15+
Ductility	(7.2°C [45°F], 1 cm/min), cm RTFO Aged Residue	T 51	10+

Absolute Viscosity	(60°C [140°F]), P Original Binders RTFO Aged Residue	T 202 T 202	1,100+ 1,500-6,000
Kinematic Viscosity	(60°C [140°F]), RTFO Viscosity/Orig. Viscosity	T 201	275+
Absolute Viscosity Ratio	(60°C [140°F]), RTFO Viscosity/Orig. Viscosity		4.0-
Flash Point, Cleveland Open Cup	C(F) Original Binder	T 48	232°+(450°+)
Solubility in Trichloroethylene	%, Original Binder	T 44	99.0+
Ductility	(25°C [77°F], 5 cm/min), cm RTFO Aged Residue	T 51	75+

Note 1 "RTFO Aged Residue" means the asphaltic residue obtained using the rolling thin film oven test (RTFO Test), AASHTO T 240.

D. EMULSIFIED ASPHALTS

1. CCS-1 cationic emulsified asphalts shall comply with the requirements listed in Table 32 12 16-3.
2. CCS-1 Cationic Emulsified Asphalt shall conform to the requirements of AASHTO M 208.

TABLE 32 12 16-3

TESTS ON EMULSION	
Viscosity @ 77°F., SSF	30 max.
Storage Stability, 1 day, %	1 Max.
Demulsibility 35 ml. 0.8% SDS, %	25 min.
Particle Charge	Positive*
Sieve, % retained	0.10 max.
Distillation Oil by Vol. of Emulsion, %	5 max.
Distillation Residue by Wt. of Emulsion, %	45 min.
TESTS ON RESIDUE	
Penetration @ 77°F.	100-200
Ductility @ 77°F., 5 cm/min., cm	40 min.
Solubility in TCE, %	97.5 min.

* If particle charge test is inconclusive, material having a max. Ph value of 6.7 will be acceptable.

E. STORAGE AND APPLICATION TEMPERATURES

1. Asphalt materials required by the Specifications shall be stored and applied within the temperatures ranges indicated below:

TABLE 32 12 16-4
STORAGE AND APPLICATION TEMPERATURES

Type and Grade of Material	Spray °F	Mix °F	Storage °F
MC-30	85+		140 Max
MC-250	165+	165-220	240 Max
RC-800	200+		200 Max
CRS-2	125-175		100-175
CMS-2	125-175	120-160*	100-175
CSS-1	90-120	90-160*	50-125
AC-2.5	270+	235-280**	325 Max
AC-5	280+	250-295**	325 Max
AC-10	280+	250-315**	325 Max
STE-1	70-140	70-150	50-125
PG58-22		350 max	275-325°F

* Temperature of the emulsified asphalt in the pugmill mixture.

** As required to achieve Kinematic viscosity of 150-300 centistokes.

2.04 ANTI-STRIP ADDITIVES

- A. Anti-strip agents shall be used in the proportions determined by ATM T-14 and shall be included in the approved Trial Job Mix Design. At least 70% of the aggregate shall remain coated when tested in accordance with ATM T-14.

2.05 PROCESS QUALITY CONTROL

- A. The Haines Borough has the exclusive right and responsibility for determining the acceptability of all materials incorporated into the Project. It is expressly understood, however, that the CONTRACTOR is solely responsible for the sampling and testing of material for process control of the asphalt concrete mixture including screening, crushing, blending, stockpiling of the aggregate, production of the asphalt concrete mixture and monitoring compaction of the asphalt concrete mixture.
- B. The results of the acceptance testing performed by the OWNER'S REPRESENTATIVE may not be available to the CONTRACTOR until a period of at least seven working days has elapsed from the date of sampling.

PART 3 - EXECUTION

3.01 WEATHER LIMITATIONS

- A. The asphalt concrete mixture shall not be placed on a surface with standing water, on an unstable roadbed when the base material is frozen, or when weather conditions prevent the proper handling or finishing of the mixture. No asphalt concrete, Type II mixture, shall be placed unless the surface temperature is 40°F or warmer.

3.02 EQUIPMENT

- A. All equipment shall be in good working order and free of asphalt concrete mix buildup. All equipment shall be available for inspection and demonstration 72 hours prior to placement of asphalt concrete.
- B. Bituminous Mixing Plants:
 - 1. Mixing plants shall conform to AASHTO M 156.

2. Proportioning (batch) scales shall not be used for weighing material for payment. Weigh scales used in conjunction with a storage silo may be used to weigh the final product for payment, provided the scales are certified.

C. Hauling Equipment:

1. Trucks used for hauling asphalt mixtures shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of either paraffin oil, lime water solution as approved by the OWNER'S REPRESENTATIVE. Diesel or fuel oil shall not be used.
2. Each truck shall have a watertight canvas cover of such size as to extend at least one foot over the sides and end of the truck bed and be adequately secured to protect the asphalt concrete mixture. The use of the canvas covers will be required at all times
3. The Contractor shall make the trucks to be used for hauling the asphalt concrete mixture available for inspection by the OWNER'S REPRESENTATIVE prior to paving day and shall be identified in the Paving Plan. Trucks that do not meet the requirements of this section may be rejected by the OWNER'S REPRESENTATIVE and not allowed on the project unless the deficiencies are remedied and approved by the OWNER'S REPRESENTATIVE in advance of hauling asphalt. Use of trucks not approved for delivery by the OWNER'S REPRESENTATIVE may result in the rejection of the asphalt concrete mixture within the unapproved truck.

D. Asphalt Pavers:

1. Asphalt pavers shall be self-propelled units, provided with a heated vibratory screed. Grade and cross slope shall be controlled through the use of automatic grade and slope control devices. The paver screed control system shall be automatically actuated by the use of a string line, or minimum 30-foot long ski. The length of the string line shall be adjusted to produce the required surface smoothness.
2. The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed.
3. The screed assembly shall produce a finished surface of the required smoothness, thickness, and texture without tearing, shoving, or displacing the asphalt concrete mixture. Screed extensions used for paving a constant width shall be heated and vibrated. Auger extensions shall be the same length as the rigid screed extensions.
4. The use of a pickup machine to transfer the asphalt mixture from a windrow to the paver hopper will be permitted, provided the pickup machine is capable of collection of the windrowed material without damage to the underlying course. The OWNER'S REPRESENTATIVE will not allow the continued use of the pickup machine if segregation, excessive temperature loss, or any detrimental effects are observed.
5. Paver hopper wings shall either be left in the top or down position throughout the paving operation. If the CONTRACTOR wishes to dump the wings during paving, the material on the wings and in the hopper shall not be incorporated into the finish mat or included in the quantity for payment.
6. The screed assembly shall have a joint compaction device and a joint edge restrainer.

E. Rollers

1. The CONTRACTOR shall supply a sufficient number and weight of rollers to compact the mixture to the required density while maintaining the pace of the paving operations. Rollers shall be of the static steel wheel, vibratory steel wheel, and pneumatic tire type, self propelled and capable of reversing without backlash. They shall be specifically designated to compact hot asphalt concrete mixtures. The use of equipment which results in crushing of the aggregate will not be permitted. Pneumatic tire rollers shall be fully

skirted; shall be at least six (6) feet wide; and shall be configured so that the rear group of tires align to cover the spaces between the front group of tires. The roller shall have an operating weight per tire of at least 3,000 pounds. Tires shall be of equal size, a minimum of 20 inches in diameter, shall be inflated to at least 80 psi and maintained so that tire pressures do not vary more than 5 psi between any two (2) tires

2. Heavy, full-size, self propelled laydown units that will place concentrated loading on curb and gutter sufficient to cause breakage, or other damage to the concrete, will not be permitted.

3.03 PREPARATION OF EXISTING SURFACE

- A. The existing surface shall be prepared in conformance with the Drawings and Specifications. Existing paved surfaces shall be cleaned of loose material by sweeping with a power broom, supplemented by hand sweeping, if necessary.
- B. Contact surfaces of curbing, gutters, manholes, and other structures shall be coated with a thin, uniform coating of tack coat material in conformance with Section 02802 - Tack Coat prior to the asphalt mixture being placed.
- C. Surfaces which have received a prime coat shall be allowed to cure such that the prime coat is not picked up by the haul vehicles. Surfaces which have received an emulsion tack coat shall be allowed to break prior to placement of asphalt concrete mixture.
- D. The grading, shaping, and strengthening where applicable, of the road surface shall be as specified in Section 02204 - Base Course.
- E. A string line installed by the CONTRACTOR at the direction of the OWNER'S REPRESENTATIVE will be the edges of paving.
- F. Prior to paving over any existing pavement, the surface shall be thoroughly cleaned and an application of tack coat applied that will provide a strong bond between the two layers.

3.04 PREPARATION OF ASPHALT

- A. A continuous supply of the asphalt cement shall be supplied to the mixer at a uniform temperature, within 25°F of the Job Mix Design mixing temperature.

3.05 PREPARATION OF AGGREGATES

- A. The aggregate for the asphalt concrete mixture shall be heated and dried to a temperature compatible with the mix requirements specified. Flames used for drying and heating shall be properly adjusted to avoid damage to the aggregate and to avoid the presence of unburned fuel on the aggregate. Any asphalt concrete mixture in which soot or fuel is present shall be wasted and no payment made.
- B. Drying operations shall reduce the aggregate moisture content to the extent that the moisture content of the asphalt concrete mixture, sampled at the point of acceptance for asphalt cement content, shall be no more than 0.5% (by total weight of mix), as determined by ATM T-25.

3.06 MIXING

- A. The aggregate, asphalt cement additives shall be combined in the mixer in the amounts required by the Job Mix Design.

- B. The materials shall be mixed such that a complete and uniform coating of the aggregate is obtained. For batch plants, dry aggregate shall be placed in motion immediately prior to the addition of asphalt cement. Wet mixing time shall be adequate to obtain 98% coated particles when tested in accordance with AASHTO T 195.
- C. The temperature of the asphalt concrete mixture at the time of the mixing shall be as determined by the Job Mix Design.

3.07 TEMPORARY STORAGE OF ASPHALT CONCRETE MIXTURE

- A. Temporary storing or holding of hot asphalt concrete mixture in silo type storage bins will be permitted.
- B. All the asphalt concrete mixture drawn from the silo type storage bins shall conform to all of the requirements for asphalt concrete mixtures as if loaded directly into hauling equipment from the mixing plant. Signs of visible segregation, heat loss, changes from the Job Mix Design, change in the characteristics of asphalt cement, lumpiness or stiffness of the mixture will be cause for rejection.
- C. Unsuitable asphalt concrete mixture shall be disposed of by the CONTRACTOR at no cost to the OWNER.

3.08 SPREADING AND PLACING

- A. The CONTRACTOR shall submit a Paving Plan for the OWNER'S REPRESENTATIVE's review a minimum of five (5) working days prior to initiating the paving operation. The Paving Plan shall consist of, but not be limited to, the following:
 - 1. Paving schedule to include sequence of operations.
 - 2. Paving schedule distributed to residents within the Project boundary.
 - 3. Operational details to include:
 - a. Plant operating capacity and target production rate.
 - b. Number and capacity of trucks, cycle time, and delivery rate.
 - c. The manufacturer and model of the paver and pickup machine, to include information on grade followers, sensors, operating speed and production rate of the pavers.
 - d. Number, type, weight, and operating speed of rollers.
 - e. Location of longitudinal joints.
 - f. Method of constructing transverse joints.
 - g. Construction plan for paving intersections and driveways.
 - h. The manufacturers, model number, and the last certified calibration date for the CONTRACTOR's nuclear densometer gauge.
- B. The asphalt concrete mixture shall be laid upon a surface approved by the OWNER'S REPRESENTATIVE, spread and struck off to the required compacted thickness. Asphalt pavers shall be used to distribute the asphalt concrete mixture in lanes of such widths as to hold to a practical minimum the number of longitudinal joints required, subject to the requirements of this Section.
- C. When laying asphalt concrete mixtures, the paver shall be operated at uniform forward speeds consistent with the delivery of asphalt concrete mix to avoid unnecessary stopping and starting of the paver.

- D. On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the asphalt concrete mixture shall be spread, raked and luted by hand tools. For such areas the asphalt concrete mixture shall be placed to the required compacted thickness.
- E. Any asphalt concrete mixture which is observed to be contaminated or segregated will be rejected.
- F. When the section of roadway being paved is open to traffic, adjacent traffic lanes shall be paved to the same elevation within 24 hours unless prevented by weather or other factors beyond the CONTRACTOR's control.
- G. When multiple lifts are specified in the contract, the final lift shall not be placed until all other lower lift pavement throughout that section, as defined by the Paving Plan, has been placed and accepted. Paving shall not begin until all adjacent curb has been poured and cured for 72 hours or until satisfactory strength is achieved.
- H. Manholes, cleanouts and water valve boxes shall be raised to grade prior to paving the final lift. The structures shall have no less than 3/8" and no greater than 3/4" depression from adjacent asphalt to top of the lid. Structures not meeting tolerances will be repaired as shown on the Drawings.
- I. Unless waived by the OWNER'S REPRESENTATIVE the asphalt pavement in the parking lots shall be paved in a single day's operation so no cold joints will result.
- J. The Contractor shall hold a pre-paving conference on site with the OWNER'S REPRESENTATIVE to review and verify the accuracy of the Paving Plan prior to paving day. The paving foreman shall be present to explain each of the operational details included in the paving plan.

3.09 COMPACTION

- A. Immediately after the asphalt mixture has been spread, struck-off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.
- B. Minimum compaction shall be 94% of AASHTO T 209. The target value for density will be 94 to 97% of the maximum specific gravity (MSG) as determined in accordance with AASHTO T 209 for the first sample from each lot of asphalt concrete mixture, as defined in this Section. Acceptance testing for field density will be determined in accordance with ATM T-18 or ASTM D-2950, as directed in writing by the OWNER'S REPRESENTATIVE.
- C. The asphalt concrete mixture, including the leveling course, shall have a minimum of three (3) complete passes with a pneumatic-tired roller prior to cooling to 175°F. A pass is defined as once over each point on the pavement surface.
- D. Areas not accessible to the rollers shall be graded with rakes and lutes and compacted with mechanical tampers. For depressed areas a trench roller may be used to achieve the required compaction.
- E. Any asphalt concrete mixture that becomes loose and broken segregated, mixed with dirt, or is any other way defective shall be removed and replaced with fresh hot asphalt concrete mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt cement shall be removed and replaced.
- F. Rollers or other vehicles shall not be parked or left standing on pavement that has not cooled sufficiently to prevent indentation by wheels.

3.10 JOINTS

- A. Joints shall be made to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.
- B. When joining old existing pavement and new pavement, the old pavement shall be cut in a neat line, with a power driven saw. All saw cuts on the Project shall be sealed with hot asphalt sealant.
- C. Improperly formed joints resulting in surface irregularities or rock segregation shall be removed, full road width, replaced with new material, and thoroughly compacted. Rolling of joints after the material has cooled below 160°F shall not be allowed. All pavement removal shall be pre-cut to a neat line using a power driven saw. The edge of pavement along the centerline joint shall not be allowed to drop below 200 degrees Fahrenheit prior to the asphalt mix from the adjacent land being placed against this edge.
- D. A thin tack coat of asphalt cement or asphalt emulsion shall be applied on all cold joints prior to placing any fresh asphalt concrete mixture against the joint. This WORK shall be completed by the CONTRACTOR just prior to paving.
- E. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course or by using a removable bulkhead.
- F. The longitudinal joints in one layer shall offset those in the layer immediately below by at least six (6) inches. The joints in the top layer shall be at centerline or lane lines except where pre-formed marking tape striping is required, in which case the longitudinal joint in the top layer shall be offset not more than one (1) foot.
- G. The density at the joints shall not be more than 2% lower than the density specified in the lanes away from the joint.
- H. Rolling at the longitudinal joint should be done from the hot side with a vibratory roller as soon as possible. The hot side should always overlap the cold side by 1 to 1.5 inches at the joint.
- I. The finished asphalt surface along the edge of curb and gutter shall be ¼ inch above the top edge of the gutter pan.
- J. All joints with existing asphalt pavement shall be resealed with asphalt cement after the new pavement has cooled to ambient temperature. All joints with concrete gutters found to have a gap shall be blown out using a weed burner torch, filled with asphalt cement, and covered with a layer of dry sand. Excess sand shall be removed, and asphalt cement placed on the concrete driveway for then one-inch from the edge of driveway shall be removed using solvent or other approved methods.

3.11 SURFACE TOLERANCE

- A. The surface will be tested after final rolling at selected locations using a ten (10) foot straightedge. The variation of the surface from the testing edge of the straightedge between any two (2) contacts with the surface shall not exceed 3/16 inch. The asphalt concrete mixture in all defective areas shall be removed and replaced. All costs associated with removal and replacement of asphalt concrete mixture in the defective areas shall be borne by the CONTRACTOR.
- B. All asphalt surfaces segregated with single large stones void of intermediate aggregate on the surface shall be removed and replaced full lane width. The surface particles shall be consistent and conform to the contract gradation.

3.12 PATCHING DEFECTIVE AREAS

- A. Any asphalt concrete mixture that becomes contaminated with wood or foreign material or is in any way defective shall be removed. Defective materials shall be removed for the full thickness of the course. The pavement shall be saw cut so that the sides are perpendicular and parallel to the direction of traffic and so that the edges are vertical. Edges shall be coated with a thin tack coat material in accordance with Section 02802 – Tack Coat. Fresh asphalt concrete mixture shall be placed in sufficient quantity so that the finished surface will conform to grade and smoothness requirements. The asphalt concrete mixture shall be compacted to the density specified. No payment shall be made for material replacing defective material. All costs associated with the patching of defective areas shall be borne by the CONTRACTOR.

3.13 ACCEPTANCE SAMPLING AND TESTING

- A. Asphalt concrete pavement will be accepted for payment based on the OWNER'S REPRESENTATIVE's approval of: the Job Mix Design; the materials; the placement and compaction of the asphalt concrete pavement to the specified depth, finished surface requirements, tolerances, and densities. Any area of finished surfacing that is visibly segregated, fails to meet surface tolerance requirements or specified thickness or densities, or is in any way defective, shall be removed and replaced with new asphalt concrete pavement. Removal and replacement of defective pavement shall be at no additional cost to the OWNER. The full depth of the new asphalt concrete mixture will be replaced: surface patching will not be allowed.
- B. Acceptance sampling and testing shall be performed by the OWNER'S REPRESENTATIVE. Acceptance testing will determine whether the materials, installation and compaction efforts used by the CONTRACTOR have met these specifications. The results of the acceptance testing performed by the OWNER'S REPRESENTATIVE may not be available to the CONTRACTOR until a period of at least seven working days has elapsed from the date of sampling.
- C. A lot will be the total asphalt placed on the Project per season. A subplot will be one Day's production on the Project. Each subplot shall be randomly sampled and tested in accordance with this Subsection for asphalt cement content, maximum specific gravity using the Rice Method, density, and gradation.
- D. Samples taken for the determination of asphalt cement content and gradation will be taken from behind the screed prior to initial compaction. Asphalt cement content shall be determined by ATM T-23. The cost of this sampling (one per subplot) will be borne by the OWNER'S REPRESENTATIVE. The CONTRACTOR shall pay for additional testing if not in compliance.
- E. ASTM D-2950 will be used to measure density. A minimum of six (6) random tests in locations determined by the OWNER'S REPRESENTATIVE will be taken from each subplot. When using ASTM D-2950, the MSG or laboratory pounds per cubic feet shall be determined by using the Rice Method, AASHTO T 209. The Rice Method, for the purposes of nuclear gauge compaction testing, replaces the Marshal Method. Acceptance testing for density will be completed by the OWNER'S REPRESENTATIVE in the following sequence:
 - 1. The OWNER'S REPRESENTATIVE will randomly sample the in-place asphalt concrete mixture with a nuclear densometer gauge. Random is defined as having no specific pattern. Frequency of this testing will be determined by the OWNER'S REPRESENTATIVE. The CONTRACTOR may request a re-test of any nuclear densometer sample not within Specification limits. The OWNER'S REPRESENTATIVE will select the sample location for the re-test. Only one (1) re-test per sample will be allowed. This acceptance testing will be paid for by the OWNER.

2. If the random density acceptance testing indicates that the density specified has not been met, further sampling and testing will be required by the OWNER'S REPRESENTATIVE. At the direction of the OWNER'S REPRESENTATIVE, the CONTRACTOR shall cut at least one (1) full depth six (6) inch diameter core sample (per lot) from the finished mat. The samples shall be neatly cut by a core drill at the randomly selected locations. Core holes for sampling shall be backfilled and compacted with hot asphalt concrete mixture within two (2) hours of sampling. The core samples will be tested for compliance with these specifications at a certified laboratory specified by the OWNER'S REPRESENTATIVE. Any sampling and testing required beyond the nuclear densometer testing by the OWNER'S REPRESENTATIVE will be paid by the CONTRACTOR.
- F. At the direction of the OWNER'S REPRESENTATIVE, samples taken for the determination of aggregate gradation may be obtained from one (1) of the following locations:
1. From the combined aggregate cold feed conveyor via a diversion chute, or from the stopped conveyor belt.
 2. For dry batched aggregates, on batch plants, the pugmill shall be cleaned by dry batching at least two (2) dry batches or until no asphalt coating is found on the aggregate. One complete batch will be dropped in a loader bucket and hand mixed thoroughly with a shovel until a sample can be taken. The sample will be used for acceptance, gradation, control, and payment.
- G. Additional materials testing will be required whenever a new Trial Job Mix Design is approved. The maximum specific gravity (MSG) for each lot will be determined from the first randomly selected sample from the first subplot. Materials testing includes, but is not limited to, gradations, extractions, density testing and core analysis.
- H. If field density is determined in accordance with ASTM D-2950, additional core samples will be required whenever a new Trial Job Mix Design is approved or whenever there is a change in the typical section. The MSG for each lot will be determined from the first randomly selected sample from the first subplot. The CONTRACTOR shall reimburse the OWNER for all materials testing beyond the first \$2,000.00. Materials testing includes but is not limited to gradations, extractions, density testing and core analysis.
- I. All tests necessary to determine conformance with the requirements specified in this Section will be performed by the OWNER'S REPRESENTATIVE and paid for by the CONTRACTOR.
- J. The frequency of materials testing for asphalt is determined by the latest edition of the Alaska Department of Transportation and Public Facilities Standard Specifications for Highway Construction. The CA/Inspector shall meet with the Project Manager prior to paving in order to determine the appropriate testing frequency.
- K. For each lot of asphalt pavement produced, at least two (2) samples shall be taken by the CONTRACTOR for purposes of acceptance testing by the OWNER. The CONTRACTOR shall split the sample with the OWNER to retain a portion for their use. The sample shall be taken according to proper sampling methods, from the asphalt pavement on the grade.

The deduction amounts will be determined from the OWNER'S acceptance testing results. The values will be calculated by averaging the amount of the absolute value of the two tests outside the job mix design tolerance (the difference between the actual test result and the job mix design tolerance range). A test value within the job mix design tolerance will be considered a zero (0) value for averaging the two values. Deduction from the asphalt pavement pay item shall be made at the following amounts:

1. #200 Sieve: the greater of either 1.0% the contract price for asphalt pavement placed within the sampled lot or \$500 per each 0.1% outside the job mix design tolerance, not exceeding 6% maximum of the percent passing the #200 sieve. The allowable tolerance for this Contract shall be $\pm 1.0\%$ of the target mix design value and shall not exceed the content limits specified in this Contract. If values fall outside of the allowable tolerance, deductions shall be calculated from the mix design target value.
2. Asphalt Content: the greater of either 1.0% of the contract price for asphalt pavement placed within the sampled lot or \$500 per each 0.1% outside the allowable job mix design asphalt content tolerance. The allowable asphalt content tolerance for this Contract shall be $\pm 0.4\%$ of the target job mix design value and not to fall below a value of 5.6%. If values fall outside of the allowable tolerance, deductions shall be calculated from the mix design target value.

The pay deductions for exceeding the job mix design tolerances does not constitute acceptance of a mix that does not meet the specification. Further acceptance testing will be performed to determine if the asphalt pavement specifications have been met. No payment for asphalt pavement will be made for asphalt pavement exceeding job mix design tolerances.

END OF SECTION

SECTION 32 13 13 – SITE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Description:
 - 1. Concrete for:
 - a. Fuel tank slabs.
 - b. Concrete aprons.
 - c. Thickened edge concrete sidewalk (if Alternate 1 is awarded).

1.2 REFERENCE STANDARDS

- A. Specific technical portions of State of Alaska Department of Transportation and Public Facilities (ADOT&PF), Standard Specifications for Highway Construction, 2015 Edition, as referenced herein.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M148 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete (Same as ASTM C309).
 - 2. AASHTO M171 - Standard Specification for Sheet Materials for Curing Concrete (Same as ASTM C171).
 - 3. AASHTO M182 - Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats.
- C. American Concrete Institute (ACI):
 - 1. ACI 301 - Specifications for Structural Concrete.
- D. American Society for Testing and Materials (ASTM) International:
 - 1. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 2. ASTM A775 - Standard Specification for Epoxy Coated Steel Reinforcing Bars.
 - 3. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - 4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - 5. ASTM C42 - Standard Specification for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
 - 6. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
 - 7. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
 - 8. ASTM C150 - Standard Specification for Portland Cement.
 - 9. ASTM C172 - Standard Practice for Sampling Freshly Mixed Concrete.
 - 10. ASTM C173 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
 - 11. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
 - 12. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
 - 13. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
 - 14. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
 - 15. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

1.3 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.

- B. Pre-Construction Submittal:
 - 1. Concrete Protection Plan for Cast in Place Concrete for ambient conditions as described in Article AMBIENT CONDITIONS and PROTECTION.
 - 2. Traffic Control Plan for Airport Road and Clinic Driveway Landing Concrete Placement.
 - a. Airport Road Concrete Pavement Placement may be included with Specification Section 31 23 17 TRENCHING traffic control plan.
 - b. See Article PROTECTION for protecting fresh concrete from traffic.
- C. Advance Notice to OWNER's Representative at least 24-hours prior to placing concrete.
- D. Product Data:
 - 1. Concrete Mix Design.
 - 2. Reinforcement.
 - 3. Joint Compound.
- E. Concrete Testing:
 - 1. Slump.
 - 2. Air Content.
 - 3. Concrete Temperature.
 - 4. Compressive Strength.

1.4 AMBIENT CONDITIONS

- A. Cold Weather Concrete - The Contractor shall submit a written cold weather concreting plan for approval to the OWNER's Representative when air temperatures are expected to fall below 35 deg F during the cure period.
 - 1. When preparing a cold weather concreting plan, follow the technical requirements found in ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.05 Cold Weather Concrete.
- B. The Contractor shall provide a written plan for wet weather concrete protection procedures prior to concrete placement.
- C. Placement of concrete shall be prohibited at an ambient air temperature of less than 40 deg F or where the foundation material is frozen, except in special situations where authorized by the OWNER's Representative in writing.
 - 1. Salt, chemicals, or other materials shall not be mixed with the concrete to prevent freezing.
 - 2. Placement of concrete is prohibited whenever there is standing water on the soil surface or in the formwork, the subgrade is soft and yielding because of saturation.
 - 3. Approved admixture shall be used in accordance with the manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 CONCRETE MIX AND MATERIALS

- A. Sidewalk and equipment slab concrete pavement use ADOT&PF Class A concrete mix as described in ADOT&PF Section 501 STRUCTURAL CONCRETE, Table 501-1 Class of Concrete.
- B. Cement: ASTM C150, Type I – Normal; use one brand of cement throughout Project work.
- C. A central mixing plant shall be used for production of the concrete mix unless otherwise noted. The plant shall provide concrete mix product in compliance with ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.04 Mixing, 2. Central Plant Mixing.

2.2 FORM MATERIALS

- A. Form Materials:
 - 1. Form Materials: Conform to ACI 301.
 - 2. Wood or steel form material, profiled to suit conditions.
 - 3. Joint Filler: Premolded joint filler shall conform to the requirements of ASTM D1751; Asphalt impregnated fiberboard.
 - 4. Joint Compound:
 - a. Polyurethane: A one part, polyurethane, self-leveling, joint sealant meeting ASTM C920, Grade P, Type S, Class 25. Color to match concrete.

2.3 REINFORCEMENT

- A. Reinforcement Materials:
 - 1. Deformed Reinforcing: ASTM A615, 60 ksi yield grade, deformed billet steel bars with ASTM A775 epoxy coating.
 - 2. Tie Wire: Minimum 16 gage annealed type.
- B. Aggregates: As required in ADOT&PF Section 501 STRUCTURAL CONCRETE, Table 501-1, Class of Concrete.
- C. Water: Potable, ASTM C94.
- D. Admixtures:
 - 1. Provide concrete admixtures that contain no more than 0.1 percent chloride ions.
 - 2. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.
 - 3. Water-Reducing Admixture: ASTM C494, Type A.
 - 4. High-Range Water-Reducing Admixture: ASTM C494, Type F or Type G.
 - 5. Water-Reducing and Accelerating Admixture: ASTM C494, Type E.
 - 6. Water-Reducing and Retarding Admixture: ASTM C494, Type D.

2.4 FABRICATION

- A. Fabricate reinforcing in accordance with Concrete Reinforcing Steel Institute (CRSI) Manual of Practice.

2.5 ACCESSORIES

- A. Curing Materials:
 - 1. Burlap cloth made from jute or kenaf meeting the requirements of AASHTO M182.
 - 2. Sheet materials for curing concrete meeting the requirements of AASHTO M171.
 - 3. Liquid membrane forming compounds for curing concrete meeting the requirements of AASHTO M148, Type 1, except do not use compounds containing linseed oil.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify compacted soil surface is dry and ready to support paving and imposed loads and required compaction densities have been achieved.

- B. Verify gradients and elevations of soil bearing surface are correct.

3.2 PREPARATION

- A. Moisten substrate to minimize absorption of water from fresh concrete.
- B. Notify OWNER's Representative minimum 24 hours prior to commencement of concreting operations.

3.3 INSTALLATION

- A. Forms:
 - 1. Place and secure forms and screeds to correct location, dimension, profile, and gradient.
 - 2. Assemble formwork to permit easy stripping and dismantling without damaging concrete.
- B. Reinforcement:
 - 1. Place reinforcing as indicated on Drawings.
 - 2. Interrupt reinforcing at expansion joints by cutting every other rebar.
- C. Transporting Concrete: Transport concrete from the central mixing plant in compliance with ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.04 Mixing, 2. Central Plant Mixing.
- D. Placing Concrete:
 - 1. Place concrete in accordance with ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.08 Placing Concrete, 1. General.
 - 2. Concrete for Airport Road and Driveway Landing shall be a continuous monolithic pour.
- E. Isolation Joints (IJ):
 - 1. IJ shall be placed along all structures and features that project into, through, or against the concrete.
 - 2. Where concrete pavement meets existing roadway pavement, the concrete shall be field cast against face of roadway pavement and underlying soil. Remove surficial loose soil along the face of the roadway pavement immediately before pouring concrete.
- F. Contraction Joints: Provide 1/4 inch wide weakened-plane transverse contraction joints. Construct contraction joints to a depth of 1 inch prior to the final set of the concrete as follows:
 - 1. Tooled Joints: Form contraction joints in fresh concrete by grooving and finishing each edge of joint with a groover tool.
 - 2. Contraction joints shall be tooled in containment apron at intervals not to exceed 10 foot intervals.
 - 3. No contraction joint in the Airport Road or Driveway Landing reinforced concrete pavement. This concrete is to be a continuous monolithic pour.
- G. Finishing:
 - 1. Sidewalk and slab pavements: Provide a finished concrete surface in accordance with ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.09 Finishing Concrete Surfaces, 4. Curb, Sidewalk, and Concrete Barrier Surfaces.
 - 2. Tooling: Tool edges of slab and joints formed in fresh concrete with a jointing tool to the following radius. Repeat tooling of edges and joints after applying surface finishes. Eliminate tool marks on concrete surfaces.
 - a. Joint Edge Radius: 1/4 inch.
 - b. Curb Edge Radius: 1/2 inch.

3.4 TOLERANCES

- A. Maximum Variation of Surface Flatness:
1. Airport Road pavement flatness to be tested using a 10-foot-long straight edge. Correct variations for the testing edge and any two contact points of more than 0.01 foot following ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.09, 3. Concrete Decks.
 2. 1/8 inch in 10 feet at all other locations.

3.5 FIELD QUALITY CONTROL

- A. Sampling and testing for quality control by the Contractor during placement of concrete shall include the following, as directed by the OWNER's Representative:
1. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
 2. Slump: ASTM C143; one test at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.
 3. Air Content: ASTM C173, volumetric method for lightweight or normal weight concrete; ASTM C231 pressure method for normal weight concrete; one for each day's pour of each type of air entrained concrete.
 4. Concrete Temperature: Test hourly when air temperature is 40 degrees Fahrenheit and below, and when 80 degrees Fahrenheit and above; and each time a set of compression test specimens is made.
 5. Compression Test Specimen: ASTM C31; one set of 3 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
 6. Compressive Strength Tests: ASTM C39; one set for each day's pour exceeding 5 cubic yards plus additional sets for each 50 cubic yards over and above the first 25 cubic yards of each concrete class placed in any one day; one specimen tested at 7 days, one specimen tested at 28 days, and one specimen retained in reserve for later testing if required.
 7. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
 8. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 9. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive by more than 500 psi.
- B. Test results will be reported to OWNER's Representative and CONTRACTOR on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
- C. Additional Tests: The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by OWNER's Representative. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. Locations of test cores must be approved by the OWNER's Representative. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- D. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

3.6 PROTECTION

- A. Wet weather protection is required.
- B. Immediately after placement, protect paving from premature drying, excessive hot or cold temperatures, and mechanical injury.
- C. Do not permit traffic over concrete pavement until at least 7 days after finishing.
- D. Concrete Pavement – Keep pavement closed to traffic until the concrete has attained at least 80 percent of its compressive strength as described in ADOT&PF Section 501 STRUCTURAL CONCRETE, 501-3.12 Backfilling and Opening to Traffic.

END OF SECTION

SECTION 32 15 00 AGGREGATE SURFACE COURSE

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Description:
 - 1. Aggregate Surface Course (ASC) product description and installation.
- B. Contractor-provided independent test laboratory/Testing Agency for all soil gradation and compaction testing requirements. Testing services shall include all equipment, labor, materials, and testing plan.
- C. Related Sections:
 - 1. Section 01 57 10 – Erosion, Sediment and Pollution Control
 - 2. Section 31 00 00 – Earthwork
 - 3. Section 31 22 13 – Rough Grading

1.02 DEFINITIONS

- A. See Specification Section 31 00 00 Earthwork.

1.03 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T96 - Test for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - 2. AASHTO T104 – Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
- B. American Society of Testing and Materials (ASTM) International:
 - 1. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- C. Specific technical portions of State of Alaska Department of Transportation and Public Facilities (ADOT&PF), Standard Specifications for Highway Construction, 2015 Edition, as referenced in this Section.
- D. Alaska Test Method (ATM):
 - 1. ATM 205 – Determining the Plastic Limit and Plasticity Index of Soils.
 - 2. ATM 207 – Moisture Density Relations of Soil.
 - 3. ATM 304 – Sieve Analysis of Fine and Coarse Aggregates.
 - 4. ATM 305 – Determining the Percentage of Fracture in Coarse Aggregate.
 - 5. ATM 313 - Degradation Value of Aggregate.

1.04 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Pre-Construction Submittal:
 - 1. Field In-Place Density Testing Plan. Provide this submittal under Specification Section 31 00 00 EARTHWORK.
- C. Laboratory Tests: Material properties, ATM 304 soil gradation, and ATM 207 optimum moisture-maximum density curve for each Soil Material.

- D. Material Source: Submit name of imported materials source.
- E. Manufacturer's Certificate: Certify products meet or exceed requirements.
- F. Field In-Place Density Testing Results and locations of all testing sites.

1.05 QUALITY ASSURANCE

- A. Furnish aggregate surface course material from single source throughout the Work.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Aggregate Surface Course: Aggregate Surface Course (ASC) shall meet the requirements of Alaska Department of Transportation and Public Facilities (ADOT&PF) Standard Specifications for Highway Construction, 2017 Edition, Table 703-2, E-1 Base Course. The following is ADOT&PF E-1 soil gradation and material properties.

Table 1: ASC Gradation Determined by ATM 304

<u>U.S. Std. Sieve</u>	<u>Cumulative % Passing by Weight</u>
1-inch	100
3/4-inch	70-100
3/8-inch	50-85
No. 4	35-65
No. 8	20-50
No. 50	15-30
No. 200	8-15

Table 2 : ASC Material Properties

<u>Property</u>	<u>Test Method</u>	<u>Requirement</u>
L.A. Wear %	AASHTO T96	45, max.
Degradation Value	ATM 313	45, min.
Fracture, %	ATM 305	70, min., 1 Face
Plastic Index	ATM 205	10, max.
Sodium Sulfate Loss, %	AASHTO T104	9, max. (5 cycles)

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify compacted substrate is dry and ready to support imposed loads.
 - 1. Proof-roll substrate with heavy vibratory roller compactor in minimum two perpendicular passes to identify soft spots.
 - 2. Remove soft substrate and not capable of compaction in place. Backfill with subbase and compact to density equal to or greater than requirements for subsequent fill material.
- B. Verify substrate has been inspected, gradients and elevations are correct.

3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.

3.03 CONSTRUCTION DURING FREEZING CONDITIONS

- A. See Specification Section 31 00 00 Earthwork, paragraph CONSTRUCTION DURING FREEZING CONDITIONS.

3.04 SOIL PLACEMENT

- A. Place soil in continuous layers as follows:
1. Aggregate Surface Course: Maximum 6-inch loose lift thickness.

3.05 TOLERANCES

- A. Top surface / finished grade of the Aggregate Surface Course shall be within 0.05 feet of required elevation.

3.06 FIELD QUALITY CONTROL

- A. Definition: Degree of compaction shall be expressed as a percentage of the maximum density obtained by the test procedure presented in ATM 207.
- B. Field in-place density shall be determined in accordance with ASTM D6938. The calibration checks of both the density and moisture gauges shall be made at the beginning of a job, on each different type of material encountered, at intervals as directed by the Owner's Representative. Copies of calibration curves, results of calibration tests, and field and laboratory density tests shall be furnished to the Owner's Representative and Contractor. When tests indicate Work does not meet specified requirements, remove soil lift, replace and retest.
- C. The following table describes minimum soil compaction density and field testing requirements.

Material/Location	Test Method	Number of Tests	Minimum Compaction Density, ATM 207
Aggregate Surface Course	ASTM D6938	Minimum of 2 per lift, 1 for each additional 2,500 sq. ft.	98%

END OF SECTION

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SECTION 323100 – VERTICAL PIVOT GATE

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The WORK includes installation of new double leaf vertical pivot gate at the Union Street and Main Street entrances as follows:
 - 1. Vertically pivoting low voltage electrically operated vehicle access gate.
 - a. Fully welded aluminum gate frame. Coordinate gate design with Owners. Gate operator of a vertical double leaf pivot type, for opening and closing the gate.
 - b. Receiving yoke.
 - 2. Photoelectric non-contact external entrapment protection devices.

1.03 RELATED SECTIONS

- A. The following Electrical Sections are referenced for coordination for installation of the Vertical Pivot Gate:

1.04 PERFORMANCE REQUIREMENTS

- A. Gate Dimensions
 - 1. Width – 30 Feet
 - 2. Height – 8 Feet
- B. Structural Performance: Engineer, fabricate, and install gate systems to withstand gate dead loads and wind live loads of 75 mph.

1.05 SUBMITTALS

- A. Product Data: Submit sufficient manufacturer's data to indicate compliance with these specifications. Mark data to indicate:
 - 1. Details of material and construction.
 - 2. Recommended installation requirements to properly accommodate the proposed Gate and accessories.
- B. Shop Drawings: Submit shop drawings for fabrication and installation of ornamental metal work. Include plans, elevations and detail sections. Indicate materials, methods, colors, finishes and types of joinery, fasteners, anchorages and accessory items. Provide setting diagrams and templates for anchorages, sleeves, and bolts installed by others. Shop drawings to be field verified by installer.

1.06 REFERENCES

- A. Comply with applicable (Federal/State/Local) code and project standards. Comply with requirements of Authorities Having Jurisdiction (AHJ) in project location.
 - 1. Standards: Comply and adhere to current Operation Control Systems and Gate Panel Construction Standards outlined in a., b., and c. below.
 - a. UL 325 - Standard for Safety for Door, Drapery, Gate, Louver, and Window Operators and Systems.
 - b. CAN/CSA-C22.2 No. 247 Operators and Systems of Doors, Gates, Draperies, and Louvers
 - c. ASTM F2200 - Standard Specification for Automated Vehicular Gate Construction.
 - 2. Electrical Components, Devices, and Accessories: NFPA 70, Article 100.

1.07 QUALITY ASSURANCE

- A. Gate Operator Manufacturer Qualifications: Minimum three (3) years documented experience producing systems specified in this section. Furnish UL 325 Listing Certification from the Nationally Recognized Testing Laboratory for Gate Operator specified in this section.
- B. Gate Panel Fabricator Qualifications: Minimum three (3) years documented experience in automated gate panel fabrication. Furnish detailed drawing of gate panel construction/fabrications that is in compliance with ASTM F2200.
- C. Installer Qualifications: An experienced installer who has completed fences and gates similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance as well as compliance with section 1.5 A. 1. previously outlined.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Store components to avoid damage from moisture, abrasion, and other construction activities. Carefully store materials off the ground to provide proper protection against oxidation caused by ground contact.

1.09 PROJECT CONDITIONS

- A. Field Measurements and Verification: Installer shall measure, verify and generate dimensions where Gate and Operator are to be located. Indicate specific location of gate with regard to existing roadways, proposed roadways, curb locations, grade changes and elevations. Indicate specific location of Gate Operator and its respective concrete foundation; include surrounding landscaping, fencing, buildings and other fixed stationary objects near the gate operator and gate panel in both open and closed positions.

1.10 COORDINATION AND SEQUENCING

- A. Coordinate gate installation with existing bollards and paving. Gate and Operator can be installed independent of paving providing that the Operator concrete foundation is in place, including electrical control conduits. Upon completion of installation, place the Gate in an open position and maintain vertically clear of traffic and surrounding bollard installation.

- B. Operators are designed for 120 volt 20 amp primary service and 24 Volt DC battery back-up (recommended two (2) Group 24, sealed 12V, Marine Starting batteries to be field supplied and installed). Installer is to coordinate electrical service with electrical design and electrical trades. Service connection is supplied via underground conduit and recommended to include a GFCI circuit breaker (subject to code or project specifications). Connection is made into a 6" square x 4" splice box inside the Operator. Within the box wire GFCI Duplex Receptacle "HOT" off of the main breaker. Receptacle may be used for loads under 20 Amps such as hand tools and the like.
 - 1. Operators in specific geographic areas ordered with Infrared Heaters require a separate independent 15 Amp power service to power the heater.

1.11 WARRANTY

- A. Standard Warranty: Provide manufacturer's standard three (3) year warranty against defective materials and workmanship after Date of Substantial Completion. Any materials, parts, components, or attachments not manufactured by AutoGate are covered by the applicable manufacturer's warranty.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURER

- A. Acceptable Products: AutoGate, Inc. Berlin Heights, Ohio. Model VPG2490 Vertical Pivot Gate System.
 - 1. Chainlink 300
- B. Requests for substitutions will be considered in accordance with provisions of the contract and bid conditions.

2.02 GATE CONSTRUCTION

- A. Materials:
 - 1. Aluminum Assembly Framing:
 - a. Plate, Shapes and Bar: ASTM B221, alloy 6061-T6 or 6063-T6.
 - b. Extrusions: Alloy and temper 6063-T6 except formed elbows shall be 6063-T4:
 - c. Round Aluminum Pipe: Standard weight extruded structural aluminum pipe, alloy 6063-T6, mill finish, complying with ASTM B429.
 - d. Provide lock washer or other locking device at all bolted connections.
 - 2. Threaded Fasteners:
 - a. All exterior screws, bolts, nut and washers shall be 300 Series non-magnetic Stainless steel.
 - b. Provide lock washers or other locking devices such as deformed thread lock or nylon locking nuts at all bolted connections.
- B. Fabrication:

1. Fabricate frames of gates from aluminum tubing. Assemble gate frames by welding at corners. Infill gate frames with panels to match adjacent fence panels or project specifications.
 2. Configuration: Size and space members in compliance with applicable codes and project specifications. All gate framing members shall be unspliced single pipe or tube length.
 3. Bracing:
 - a. Provide diagonal welded pipe gate trusses to prevent sag.
 - b. Cable Wind Bracing: Required for gates between 16' or more in length and up to 20' in length. Provide 3/16 aircraft coated cable anchored to the operator and at approximately 2/3 the length of the gate.
 - c. Masted Wind Bracing: Required for gates over 20' or more in length or more than 7' in height, and/or code requirement beyond 75 mph winds.
 1. Provide continuous tube elements which attach to the operator and extend a minimum of 2/3 the length of the gate. Wind bracing is also secured to the bottom of the gate with strut plates.
 4. Fully assemble gate leaves in the manufacturer's shop with no joints splices or bolted sections. Open tube ends or sections are not acceptable.
 5. Welding: Make exposed joints butt tight, flush, and hairline. Continuously seal joined members by continuous welds.
- C. Fabricated frame and infill fabrics: Epoxy coating, PVC Coating, or unpainted mill finish fabrics to match fence line or project specifications color.
- D. Provide components required for receiving yoke anchorage of gate ends. Fabricate anchors and related components of material and finish matching gate frame or specified color.

2.03 GATE OPERATORS

- A. Provide gate operator system, including gate operator, field supplied manufacturer recommended batteries, external entrapment B1 type Non-Contact sensing devices.
1. Gate Speed: Fully open to fully closed and fully closed to open not less than 10-12 seconds.
 2. Frequency of Use: Continuous duty.
 3. Battery Powered Back Up DC Drive System: Operator to run on 24 Volt DC current integral power supply with stand-by battery system with built-in battery maintainer and "over-charge" protection.
 - a. Field supplied: Provide two (2) 12v batteries, complying with gate operator manufacturer's requirements (Group 24, 12 Volt, Sealed Marine Starting).
 - b. Power supply to operator: 120VAC (20 Amp) .
 4. Gate Operator Enclosure: Fabricate operator enclosure from steel tubing and sheet metal. Continuous seal weld all frames seams with welds ground smooth. Screwed frames are not acceptable.
 - a. Frame: 2" Sq., 11 Ga. (.120) Steel Tubing
 - b. Skins: 18 Ga. Galvanneal Sheet
 - c. Doors: 14 Ga. Galvanneal Sheet

- d. Mounting Pads: 3" wide x 3/8" thick 304 Stainless Steel.
 - e. Finish: Standard Operator skins are powder coated Black. Gate panels and optional operator skins colors are finished with AutoGate's spray application for the color of dark green.
 - 5. Mechanical Gate Operator Drive:
 - a. 24 VDC high torque gear motor and DBL reduction DBL "V" belt design.
 - b. Integral right-angle Anti-Back drive and locking preventing falling and unauthorized motor operation.
 - c. Hydraulic components of any kind are not acceptable.
 - 6. Control Circuitry: Solid state coated AutoGate Genesis® Control Board in electrical enclosure. Sealed gate position sensor ensures weather and moisture-proof integrity. (Boards tested to -40° F).
 - a. Internal Operator Factory Wiring: 16 & 18 Ga. single conductor. Copper w/electrolytic copper compression terminals tin-plated for maximum corrosion prevention.
 - b. Accessories. Consult accessory manufacturer for installation and specific wiring instructions.
- B. Gate Operator System shall be Listed to UL 325 Class II and the gate panel shall be fabricated in accordance with ASTM F2200.
 - 1. Type A Entrapment Sensing Device - Operator shall have inherent gate position and speed sensing system as part of the gate operator system. Type A shall be constructed such that it may not be removed or bypassed.
 - 2. Operator shall have provision for connection of Control System and for connection of or supplied with External Entrapment Sensing Devices specified herein after.
- C. External Entrapment Sensing Device: Provide the following external entrapment protection devices as appropriate for the specific site conditions to address all potential entrapment zones. All entrapment areas/zones must be identified by the installer and have physical restrictions of pedestrian access such as fence sections or barrier screening preventing reach through or standing in the entrapment zone or the installer shall supply additional external entrapment protection devices to protect pedestrians in all entrapment areas.
 - 1. Photo Beams Type B1 - Non-contact sensor; Acceptable Products:
 - a. EMX Industries Model#: IRB-MON Transmitter / receiver type
 - b. EMX Industries Model#: IRB-RET Retro-reflective type
 - c. OMRON E3K-R10K4
- D. Operator Options:
 - 1. Provide Audible/Audible-Visual Warning Device(s) activated when gate is in motion.
 - 2. Provide External Emergency Stop Button

2.04 CONTROL SYSTEMS

- A. Operation control system: Safety devices, and weatherproof enclosures; coordinate electrical requirements with electrical system.
 - 1. Card Reader: Functions only when authorized card is presented. Model: HID SIGNO 20.
 - 2. Vehicle Loop Detector.
 - 3. Vehicle Remote Controller Detector (Farpoint).
 - 4. Fire Alarm Input.

2.05 ACCESSORIES

- A. Optional Items
 - 1. Gearmotor Heat Cable: Provide thermostatically controlled electric heat cable to maintain favorable operational temperature. Contact AutoGate for geographical recommended or required locations for the gearmotor heat cable.
 - 2. Auxiliary Infrared heater in cabinet.
 - 3. Heat Mat: Provide thermostatically controlled heat mat for the “throat” area of the operator to melt any buildup of snow.
 - 4. Extreme Cold/Artic Operator Heat system: Provide an insulated Operator Cabinet and include a thermostatically controlled electric infrared heater.

2.06 SETTING MATERIAL

- A. Ready-mixed concrete complying with ASTM C94: Normal-weight concrete 3000-psi 28 days compressive strength, 3-inch slump, and aggregate.
 - 1. Portland cement: ASTM C150, Type I.
 - 2. Aggregates: ASTM C33, 1-inch maximum size.
- B. Reinforcing Bars: ASTM A615 or governing code/project specification.
- C. Service and control conduit: Rigid Schedule 80 PVC embedded in concrete. All other conduit and wiring as specified in Division 26.
- D. Expansion Bolts: Threaded or wedge type; galvanize ferrous castings, ASTM A47 malleable iron or ASTM A27 cast steel.

PART 3 – EXECUTION

3.01 EXAMINATION

- A. Installer's Examination: Examine conditions under which construction activities of this section are to be performed and ensure all specified criteria is adhered to.
- B. Submit written notification to Architect/Engineer, Authority Having Jurisdiction, and system manufacturer if such conditions are unacceptable or in question.
- C. Beginning installation constitutes installer's acceptance of conditions.

3.02 ELECTRICAL SERVICE & CONTROLS

- A. Provide all power and control wiring required for the work in accordance with the applicable provisions of Division 26 and NFPA 70.
- B. Perform all trenching and backfilling associated with this Section. Conduit shall be direct buried except under areas of vehicular traffic where it shall be reinforced concrete encased.
- C. Grounding system: All equipment and branch circuits shall be grounded. Provide separate ground wire in all branch circuits.

3.03 PADS & RECEIVING YOKES

- A. Foundations: Construct pads and yoke bases as indicated on the drawings with top of concrete flat and level.
- B. Excavation:
 - 1. Locate concrete foundations for operator base on firm, undisturbed soil.
 - 2. Yoke Excavation: Drill or hand-excavate holes.
- C. Vibrate or tamp concrete for consolidation. Finish top of foundations, smooth and even. Cure concrete 72 hours before place operator.
- D. Fasteners: Install operators and receiving yoke plates with expansion bolts or hardware provided by the Gate system manufacturer.

3.4 OPERATOR INSTALLATION

- A. Install units in accordance with the manufacturer's instructions.
 - 1. Operator Expansion Bolt Mounting: Anchor through operator footpad holes to concrete substrate only after operator final position on pad has been confirmed for exact site needs and operation.
 - 2. Install all loose shipped operator lower panels, debris shields if ordered, screening, and guarding per manufacturer instructions.
- B. External Entrapment Sensing Device: Installer shall be responsible for providing, installing, and testing all external entrapment protection devices as appropriate for the specific site conditions to protect pedestrians in all potential entrapment zones. Identifying all potential entrapment zones and the proper operation of these safety devices shall be verified and training as to the operation and maintenance of these devices for the users and owners shall be conducted and documented.

3.04 GATE INSTALLATION

- A. Connect gate to operator in accordance with gate manufacturer's instruction.
- B. Install gate so that it is plumb and level when fully closed within the following tolerances:
 - 1. Maximum misalignment from true position: 1/4 inch (6.0 mm).
 - 2. Maximum misalignment between adjacent separated members: 1/8 inch (3.0 mm).

3.5 ADJUSTING

- A. Adjust and lubricate operating components for smooth, accurate operation free of binding and racking.

3.5 START-UP AND DEMONSTRATION

- A. Manufacturer's Service Representative: Provide at least 2 hours of manufacturer's representatives time for start-up and initial operation. Make a final check of each gate operation with Owner's personnel present and immediately before date of substantial completion or commissioning.
- B. Instruct Owner's personnel in proper use, operation, hazards, and maintenance of gate. Review emergency provisions, including procedures to be followed if gate does not close or open. Review and demonstrate manually opening and closing the gate system in the event of total loss of power.
- C. Instruct Owner's personnel in proper use, operation, and maintenance of all accessories and entrapment protection devices and provisions such as but not limited to: lights, vehicle presences systems, access controls, photo eyes, contact sensors, barrier screening or fencing, etc.
- D. Train Owner's personnel in normal procedures to be followed in checking for sources of damage to wind bracing, operational failures, or malfunctions.
- E. Full Wind Rating and Derating: Full wind load rating is subject to the wind bracing remaining in excellent condition and not compromised. Periodic inspection is a must in order to maintain full wind load rating. Any dents, bends, nicks and loose bolts will affect the performance of the bracing must be corrected or repaired. Additional, non-factory supplied signage must be approved by manufacturer.
- F. Determine that control systems and operating devices are functioning properly.
- G. Fill out and sign manufacturer provided Gate Installation Checklist. Installer to retain copy for records. Provide copy to owner, General Contractor, and requesting parties or other Authorities Having Jurisdiction (AHJ).

3.5 CLEANING AND PROTECTION

- A. Remove dust or other foreign matter from component surfaces. Clean finishes in accordance with manufacturer's instructions. Clean units in accordance with the manufacturer's instructions.
- B. Protection: After installation, protect installed work until project completion.
 - 1. Ensure that finishes and structure of installed systems are not damaged by subsequent construction activities.
 - 2. If minor damage to finishes occurs, repair damage in accordance with manufacturer's recommendations; provide replacement components if repaired finishes are unacceptable to Architect/Engineer.

END OF SECTION

SECTION 32 31 13 – CHAINLINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Description:

1. Fence framework, fabric, and accessories.
2. Excavation for post bases.
3. Concrete foundation for fence posts and gates.
4. Manual gates and related hardware.

1.2 REFERENCES

A. ASTM International:

1. ASTM A121 - Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
2. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
5. ASTM B429 - Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
6. ASTM F552 - Standard Terminology relating to Chain Link Fencing.
7. ASTM F567 - Standard Practice for Installation of Chain-Link Fence.
8. ASTM F626 - Standard Specification for Fence Fittings.
9. ASTM F900 - Standard Specification for Industrial and Commercial Swing Gates.
10. ASTM F1043 - Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
11. ASTM F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
12. ASTM F1184 - Standard Specification for Industrial and Commercial Horizontal Slide Gates.

1.3 SYSTEM DESCRIPTION

- A. Fabric Width: 8 feet.
- B. Line Post Spacing: At intervals not exceeding 10 feet.
- C. See Project drawings for fence location and details.

1.4 SUBMITTALS

- A. Section 013300 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings:
1. Personnel Gates.
- C. Product Data: Submit data for all fence and gate products in Part 2 PRODUCTS used for Project Work.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

- E. Alaska DOT Standard Drawings: Submit copies of all standard drawings referenced in the plans.

1.5 CLOSEOUT SUBMITTALS

- A. Section 017000 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Accurately record actual locations of property perimeter posts relative to property lines and easements.
- C. Operation and Maintenance Data: Procedures for submittals.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum five (5) years documented experience.
- B. Installer: Company specializing in performing work of this section five (5) years documented experience in the State of Alaska.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Section 016000 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver fence fabric and accessories in packed cartons or firmly tied rolls.
- C. Identify each package with manufacturer's name.
- D. Store fence fabric and accessories in secure and dry place.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Framing (Steel): ASTM F1083 Schedule 40 galvanized steel pipe, welded construction, minimum yield strength of 30 ksi; coating conforming to ASTM F1043 Type 1.
- B. Fabric Wire (Steel): ASTM A392 Class 1 zinc coated 9 gauge steel wire.
- C. Fittings: All steel fittings shall be zinc or aluminum coated per ASTM F626. Minimum zinc coating of 1.2 ounces of zinc or aluminum alloy per square foot of fitting surface.
- D. Fence Post Concrete: Portland Cement Concrete, 2,500 psi strength at 28 days.
 - 1. ADOT&PF, Standard Specifications for Highway Construction, Class W portland cement concrete.

2.2 COMPONENTS

- A. Line Posts: Schedule 40 steel pipe with at least 1.8 ounces of zinc coating per square foot of surface area, conforming to ASTM F1083, Type 1.
 - 1. Fence Fabric Width 72 inches or less, 2.0-inch outside diameter
 - 2. Fence Fabric Width greater than 72 inches but less than 108 inches, 2.5-inch outside diameter.
 - 3. Fence Fabric Width 108 inches to 144 inches, 3.0-inch outside diameter.
- B. Corner and Terminal Posts: Schedule 40 steel pipe with at least 1.8 ounces of zinc coating per square foot of surface area, conforming to ASTM F1083, Type 1.
 - 1. Fence Fabric Width 72 inches or less, 2.5-inch outside diameter
 - 2. Fence Fabric Width greater than 72 inches but less than 108 inches, 3.0-inch outside diameter.
 - 3. Fence Fabric Width 108 inches to 144 inches, 4.0-inch outside diameter.
- C. Swing Gate Posts: Schedule 40 steel pipe with at least 1.8 ounces of zinc coating per square foot of surface area, conforming to ASTM F1083, Type 1.
 - 1. Man Gate Width:
 - a. Up to 72 inches, 3.0-inch outside diameter.
 - b. 72 inches to 144 inches, 4.0-inch outside diameter.
- D. Rails and Braces: Schedule 40, 1.625-inch outside diameter, steel pipe with at least 1.8 ounces of zinc coating per square foot of surface area, conforming to ASTM F1083, Type 1.
- E. Gate Frame: Schedule 40 steel pipe with at least 1.8 ounces of zinc coating per square foot of surface area, conforming to ASTM F1083, Type 1. Pipe diameter shall be at least 1.5 inches.
- F. Fabric: ASTM A392 Class 1 zinc coated 9 gauge steel wire in a 2 inch diamond mesh. Top selvage to be twisted and barbed, bottom selvage to be knuckled.
- G. Tension Wire: 7 gage steel, single strand, marcelled, minimum coating of 0.80 ounces of zinc or 0.40 ounces of aluminum per square foot of wire surface, tension wire conforming to ASTM A824.
- H. Tension Band: Pressed steel, 14 gauge thickness x 3/4 inch wide.
- I. Tension Bar: Steel strip, 5/8 inch wide x 3/16 inch thick.
- J. Tie Wire/Hog Rings:
 - 1. Aluminum, 9 gauge single strand wire, alloy 1100-H4 or equal.
 - 2. 11 gauge steel wire with a minimum zinc coating of 0.80 ounces per square foot of wire surface.

2.3 ACCESSORIES

- A. Post Caps: Pressed steel, conforming to ASTM F626, designed to fit snugly over top end of posts to exclude moisture. Cone type caps for terminal posts and loop type for line posts.
- B. Fittings: All ferrous fittings shall be galvanized with a zinc coating with not less than 1.2 ounce per square foot of actual surface and shall conform to ASTM F626. Zinc-coated surfaces shall be free from

imperfectly coated spots, bruised or scaled coating, drops of zinc, sharp projections, and sal ammoniac spots.

- C. Gate Hardware: See Drawings.

2.4 GATES

- A. General:

1. Gate Types, Opening Widths and Directions of Operation: As indicated on Drawings.
2. Factory assemble gates.
3. Design gates for operation by one person.

- B. Swing Gates:

1. Fabricate gates to permit 180 degree swing.
2. Gates Construction: ASTM F900 with welded corners. Use of corner fittings is not permitted.

2.5 FINISHES

- A. Components and Fabric: Galvanized to ASTM A123 for components; ASTM A153 for hardware; ASTM A392 for fabric; 1.8 oz/sq ft coating.
- B. Hardware: Galvanized to ASTM A153, 1.8 oz/sq ft coating.
- C. Accessories: Same finish as framing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install framework, fabric, accessories and gates in accordance with ASTM F567.
- B. Set intermediate, terminal, gate, and pull posts plumb, in concrete footings with top of footing 2 inches above finish grade or as shown in the Project drawings. Slope top of concrete for water runoff.
- C. Line Post Footing Depth Below Finish Grade: See Project drawings. Where soil conditions allow, the preferred post installation method is using a post driver.
- D. Corner, Gate and Terminal Post Footing Depth Below Finish Grade: See Project drawings.
- E. 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.
- F. Where top rail occurs, install top rail through line post tops and splice with 6 long rail sleeves. See Project drawings for occurrence of top rail or top tension wire.
- G. Place fabric on outside of posts and rails.
- H. Do not stretch fabric until concrete foundation has cured 7 days.
- I. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.

- J. Position bottom of fabric 2 inches above finished grade or as indicated on Project Drawings.
- K. Fasten fabric to top rail or top tension wire, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on center.
- L. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- M. Install bottom and top tension wire stretched taut between terminal posts.
- N. Install support arms sloped outward and attach barbed wire; tension and secure.
- O. Support gates from gate posts. Do not attach hinged side of gate from building wall.
- P. Connect to existing fence at an existing terminal post or new terminal post or existing line post converted to terminal post by installation of brace rails and brace rods.
- Q. Install posts with no more than 6 inches clear opening from end posts to buildings, fences and other structures.
- R. Where concrete footings are required, excavate holes for posts to diameter and spacing indicated on Project drawings without disturbing underlying materials.

3.2 ERECTION TOLERANCES

- A. Section 014000 - Quality Requirements: Tolerances.
- B. Maximum Variation From Plumb: 1/4 inch.
- C. Maximum Offset From Indicated Position: 1 inch.
- D. Minimum distance from property line: 6 inches.

END OF SECTION

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SECTION 32 92 19 - SEEDING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 DESCRIPTION

- A. The WORK under this Section includes providing all labor, materials, tools and equipment and mobilization and demobilization of any equipment necessary for preparing the ground and furnishing and applying seed, fertilizer, lime and mulch in a hydroseed mixture as called for in the Contract Documents, all in reasonably close conformity with these Specifications and at locations shown on the Drawings or established by the ENGINEER.
- B. It is the intent of these Specifications is to produce a living vegetative cover of grass in the areas indicated to be topsoiled and hydroseeded as shown on the Drawings.
- C. Seed mix to be used will be as specified in Part 2, Products below.

1.02 SUBMITTALS

- A. Seed mix with signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six months of delivery. The statement shall include: Name and address of laboratory; date of test; lot number for each kind of seed; and results of tests as to name, percentages of purity and germination, and percentage of weed content, for each kind of seed furnished, and, in the case of a mixture, the proportions of each kind of seed.
- B. Fertilizer

PART 2 - PRODUCTS

2.01 SEED

- A. Seed shall be furnished separately or in mixture in standard sealed containers clearly labeled with Seed name; lot number; net weight; percentages of purity and of germination and hard seed; and, percentage of maximum weed seed content.
- B. Seed mix shall conform to the following:
 - 50% Kentucky Blue Grass
 - 25% Red Fescue
 - 25% Perennial Rye Grass

2.02 FERTILIZER

- A. Fertilizer shall be a standard commercial grade fertilizer, supplied separately or in mixtures. Fertilizer shall conform to all State and Federal regulations and shall be 10-20-20. The fertilizer shall contain slow release nitrogen in the form of inorganic chemicals amounting to at least 75% of the available nitrogen specified. Submit material certification for fertilizer.

- B. Fertilizer shall be furnished in new, clean, sealed, moisture-proof, and properly labeled containers, clearly labeled with the name, weight, and guaranteed analysis of the contents.
 - C. Fertilizer for use in a hydraulic sprayer shall be soluble or ground to a fineness that will permit complete suspension of all insoluble particles in the water or slurry.
- 2.03 LIME
- A. Lime shall be agricultural ground limestone containing not less than 85% dolomite, with 95% passing through a 100-mesh screen, delivered to the site in the original unopened containers labeled to show analysis.
 - B. Limestone for use in a hydraulic sprayer shall be soluble or ground to a fineness that will permit complete suspension of all insoluble particles in the water or slurry. Submit certification of lime material.
- 2.04 MULCH
- A. Mulch shall be natural or cooked wood cellulose fiber which shall have the property of dispersing readily in water and shall have no toxic effect when combined with seed or other materials. The homogeneous slurry or mixture shall be capable of application with power spray equipment. A colored dye which is non-injurious to plant growth may be used when specified. Wood cellulose fiber shall be packaged in new, labeled containers, shall have an equilibrium air-dried moisture content of 12% plus or minus three percent at the time of manufacture, and shall have a pH range of 3.5 to 5.0.

PART 3 - EXECUTION

3.01 SOIL PREPARATION

- A. After grading, and topsoiling has been completed in conformity with the lines and grades shown on the Drawings or staked by the ENGINEER, and before start of seeding operations, the areas to be seeded shall be cultivated to provide a reasonably firm, but friable seedbed. Cultivation shall be carried to a depth of two-inches, except on slopes steeper than 3:1. Depth of cultivation may be reduced as directed by the ENGINEER. All cultivated areas shall be raked or cleared of stones one inch in diameter and larger. All weeds, plant growth, stick, stumps, and other debris or irregularities which might interfere with the seeding operation, growth of grass, or subsequent maintenance of the grass covered areas, shall be removed.

3.02 SEEDING SEASONS

- A. All seeding shall be completed after May 1st and prior to August 15th, or the contract deadline, whichever is sooner. Seeding other than the specified dates will be allowed only with prior written permission of the ENGINEER and will be at the CONTRACTOR's own risk. If the seeding fails to produce a uniform and fecund growth, the seeding will be repeated until the required growth is achieved.
- B. Seeding shall not be done during windy conditions, or when climactic conditions or ground conditions would hinder placement or proper growth.

3.03 APPLICATION METHOD

- A. Seed, fertilizer, ground limestone and mulch material shall be placed by the Hydraulic Method for this project. One slurry unit of hydroseed mixture is to cover a 10,000 square foot area.

- a) Seeding by hydraulic methods shall consist of furnishing a slurry made of seed, fertilizer, ground limestone, wood cellulose fiber mulch, and water, and applying the slurry under pressure to the designated approved topsoil areas.
- b) A slurry unit shall consist of a mixture of the following proportionate quantities of water, mulch fiber, seed, fertilizer and ground limestone:

Water	1,000 gallons
Mulch Fiber	200 pounds
Seed	35 pounds
Fertilizer	120 pounds
Ground Limestone	500 pounds

- c) An adequate scale shall be provided by the CONTRACTOR to weigh the mix proportions and provide evidence to the ENGINEER that the correct slurry unit proportions are being used.
- d) The mixing and application shall be as follows:
 - 1. Fill the tank with water to one-third full and agitate at half speed. Add fertilizer, ground limestone and one-half the required mulch fiber.
 - 2. Fill the tank to two-thirds full and agitate at full speed. Add the remaining mulch fiber.
 - 3. Agitate at full speed and add water until the tank is full, then add the seed. Begin slurry distribution after five minutes of agitation.
- e) After fertilizer and seed are placed in the hydraulic seeder, the mixture shall be completely applied within one hour. Seed remaining in contact with fertilizer for more than one hour shall be rejected and additional seed at the specified rate shall be added at no additional cost to the OWNER.
- f) The slurry mixture shall be spread uniformly at the application rate, as directed by the ENGINEER, upon the areas designated. Application rates shall be one slurry unit per 10,000 square feet, as directed by the ENGINEER
- g) Hydraulic seeding equipment shall be capable of maintaining a continuous agitation so that a homogeneous mixture can be applied through a spray nozzle. The pump shall be capable of producing sufficient pressure to maintain a continuous, non-fluctuating spray capable of reaching the extremities of the seeding area with the pump unit located off of the approved topsoil areas. Sufficient hose shall be provided to reach areas not practical to seed from the nozzle unit situated outside of the approved topsoil areas.
- h) Surfaces that could potentially be sprayed by the hydroseed mixture that are not identified as areas to be seeded must be protected before the application of the mixture, or cleaned after application. This includes the wooden fences, sprinkler heads, concrete sidewalks/slab areas and gravel paths.

3.04 MAINTENANCE OF SEEDED AREAS

- A. The CONTRACTOR shall protect seeded area against traffic by warning signs, barricades, safety fencing as approved by the ENGINEER. Surfaces gullied or otherwise damaged following seeding shall be repaired by re-grading, re-seeding, and re-mulching, as directed by the ENGINEER, and the CONTRACTOR shall otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the WORK.
- B. The seeded areas shall be watered by the CONTRACTOR as required for proper germination and growth. Equipment used in watering shall be capable of reaching all seeded areas and not disturb the topsoil material by rutting etc.

3.05 INSPECTION AND ACCEPTANCE

- A. Acceptance of seeded areas shall be based on a uniform stand of vegetation at the time of final inspection. Areas failing to show a uniform stand after germination shall be scarified and reseeded as herein specified.

END OF SECTION

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SECTION 33 11 00 – WATER SERVICE

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The WORK under this Section includes providing all labor, materials, tools, mobilization and demobilization and equipment necessary for furnishing and installing buried HDPE water service supply pipe from the connection to the existing Haines Borough water stub out location to the new mechanical chase. The CONTRACTOR shall install the water pipe and fittings to the horizontal and vertical alignment shown on the Drawings and shall complete all associated WORK described in this Section.

1.3 SUBMITTALS

- A. HDPE water pipe material certifications stating conformance with requirements of this section and that materials meet NSF 61 certification for public drinking water.

PART 2 – PRODUCTS

2.1 PIPE

- A. High Density Polyethylene Pipe (HDPE) and fittings are to be manufactured in accordance with AWWA C906 with the additional stipulation that the HDPE is to be manufactured from PE4710 polyethylene compounds that meet or exceed ASTM D3350 Cell Classification 445574. HDPE pipe and fitting material compound is to contain color and ultraviolet (UV) stabilizer meeting or exceeding the requirements of Code C per ASTM D3350. All fittings are to have pressure class ratings not less than the pressure class rating of the pipe to which they are joined.
- B. HDPE water service pipe shall be DR 11, 200 psi pressure rating.
- C. The individual who performs the joint fusion shall have written certification from an HDPE pipe manufacturer or supplier stating he/she has successfully completed a certification class on joint fusion techniques and procedures.
- D. All HDPE pipe shall be installed with a No. 10 AWG high-strength copper clad steel with a 30-mil HDPE insulation jacket (color blue) tracer wire and have a 600-pound average tensile break load. Tracer wire is to be manufactured by Copperhead Industries or an approved equal. The tracer will shall be continuous from the water well location to the mechanical room.
- E. All HDPE molded fittings and fabricated fittings shall be fully pressure rated to not less than the pipe SDR pressure rating specified. All fittings shall be molded or fabricated by the manufacturer. No Contractor fabricated fittings shall be used unless approved by the ENGINEER.
- F. All HDPE fittings shall be installed using butt-fused fittings, and must be approved by the ENGINEER.
- G. Electrofusion couplers are discouraged and may only be allowed only with prior, written approval of the Engineer.

2.2 UNDERGROUND MARKING TAPE

- A. Underground marking tape shall be blue, six inch wide, four mil thick, polyethylene tape with black lettering with the following wording: "Caution: Waterline Buried Below." Marking tape shall be installed 12 inches above the top of all water pipe.

PART 3 – EXECUTION

3.1 GENERAL

- A. The CONTRACTOR shall preserve and protect all existing utilities and other facilities including but not limited to: telephone, television, electrical, water and sewer utilities, surface or storm drainage, and survey monuments. The CONTRACTOR shall immediately repair or replace utilities or other facilities damaged during construction. The CONTRACTOR shall support and protect any underground utility conduits, pipes, or service lines where they cross the trench.

3.2 INSTALLATION

- A. Water pipe shall be installed in accordance with the manufacturer's printed specifications and instructions, and in conformance with AWWA C151.
- B. The water pipe shall be handled carefully to prevent damage to the pipe. Water pipe and fittings shall be loaded and unloaded using hoists and slings to avoid shock or damage, and under no circumstances shall they be dropped, skidded, or rolled. If any part of the HDPE pipe is damaged, repair thereof shall be made in a manner satisfactory to the ENGINEER at the CONTRACTOR's expense.
- C. All water pipe and fittings shall be inspected for defects. Damaged pipe will be rejected and the CONTRACTOR shall immediately place all damaged pipe apart from the undamaged and shall remove the damaged pipe from the site within 24 hours.
- D. Whenever it becomes necessary to cut a length of water pipe, the cut shall be made by abrasive saw or by special pipe cutter.
- E. All pipe ends shall be square with the longitudinal axis of the water pipe and shall be reamed and smoothed to ensure a good connection.
- F. The water supply pipe shall be laid to the horizontal and vertical alignment shown on the Drawings. Fittings shall be installed at the location shown on the Drawings.
- G. To prevent dirt and other foreign material from entering the pipe and fittings during handling and installation, the open end of the pipe shall be protected by a water-tight plug at all times except when joining the next section of pipe.
- H. Under no circumstances shall pipe deflections, either horizontal or vertical, exceed the manufacturer's printed recommendations. Where deflections would exceed the manufacturer's recommendations, fittings shall be used.
- I. HDPE pipe shall be joined in continuous lengths on the jobsite above ground. Final connections of the continuous lengths may be made in the trench. The joining method shall be the butt fusion method and shall be performed in strict accordance with the manufacturer's recommendations.

- J. The CONTRACTOR shall provide and submit to the ENGINEER for review and approval an HDPE fusion plan prior to beginning pipe fusion. The plan shall include:

1. CONTRACTOR's fusion machine including make, model and year.
2. Certification and documented experience for individual(s) performing the pipe fusion.
3. Temperatures and pressures to be used for the HDPE pipe.
4. Fusion machine manufacturer's procedures for pipe fusion.
5. Fusion data logger or other approved method of Joint Data Recording - The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

3.3 FLUSHING

- A. Prior to acceptance, the CONTRACTOR shall flush the water pipe then perform hydrostatic tests. Flushing is required of all installed water pipes to remove any foreign matter. The CONTRACTOR shall furnish, install and remove all pumps, fittings and pipes necessary to perform the flushing; shall provide all additional excavation and backfill; and shall dispose of all water and debris flushed from the water pipe. A flushing scheme and schedule shall be submitted by the CONTRACTOR for review and approval by the ENGINEER prior to flushing.

3.5 HYDROSTATIC TESTING

- A. Defective materials or poor quality of WORK, discovered as a result of the hydrostatic tests, shall be replaced by the CONTRACTOR. Whenever it is necessary to replace defective material or correct the workmanship, the hydrostatic test shall be repeated until a satisfactory test is obtained.
- B. The ENGINEER shall be present for all hydrostatic and leakage tests. The CONTRACTOR shall notify the ENGINEER at least 24 hours prior to any test and shall notify the ENGINEER at least two hours in advance of the scheduled time if the test is to be cancelled or postponed.
- C. Newly installed water supply pipe is to be hydrostatically tested in two phases to whichever is greater: 150 PSI or 1.5 times the operating pressure. Acceptance pressure testing shall be done with the service line installed, corporation stops open, and pressure against the closed valves.

Phase 1 – Initial Expansion (4 hours) Pressurize the test section to the test pressure and maintain for four (4) hours. The contractor is to pump in additional test water into the pipe to maintain test pressure as the pipe expands slightly. It is not necessary to monitor the amount of water added during this phase.

Phase 2 – Pressure Testing (minimum 1 hour) Immediately following the initial expansion phase the Contractor is to stop adding testing fluid and then reduce pressure by 10 psi. The reduced pressure then becomes the test pressure and is to be held within five percent (5%) for one hour and show no visible leaks to be deemed as having passed the test. The maximum test duration is eight (8) hours. If the test is not completed in the maximum duration period, then the Contractor is to depressurize the test section completely and allow it to relax for at least eight (8) hours before pressurizing the test section again.

Correct ALL visible leaks, whether indicated during pressure testing or not.

3.2 DISINFECTION

- A. Disinfection by chlorination of all new water pipe shall be completed and a satisfactory bacteriological report obtained prior to placing the pipe in service. "Open-bore" flushing shall be completed before chlorination is begun.
- B. Chlorine shall be applied by one of the following methods:
 - 1. liquid chlorine gas-water mixture;
 - 2. direct chlorine gas feed; or
 - 3. hypochlorite commercial products such as HTH, Perchlolen, Macho-chlor, or approved equal.

The chlorinating agent shall be applied at the beginning of the section adjacent to the feeder connection, insuring treatment of the entire water pipe. Water shall be fed slowly into the new water pipe with chlorine applied in amounts to produce a dosage of 50 ppm. Application of the chlorine solution shall continue until the required residual of not less than 50 ppm free chlorine is evident at all extremities of the newly constructed line. The chlorinating agent shall be certified for disinfection of potable drinking water systems according NSF/ANSI 60 and satisfy the requirements of applicable ANSI/AWWA standards. Chlorinating agents for pools and/or spas are not allowed.

- C. The chlorine gas-water mixture shall be applied by means of a solution-feed chlorinating device. Chlorine gas shall be fed directly from a chlorine cylinder equipped with a suitable device for regulating the rate of flow and the effective diffusion of gas within the water pipe. Hypochlorite products shall be placed or injected into the water pipe. During the chlorination process, all intermediate valves and accessories shall be operated. Valves shall be manipulated so that the strong chlorine solution in the water pipe being treated will not flow back into the pipe supplying the water.
- D. A residual of not less than 50 ppm free chlorine shall be produced in all parts of the water pipe. After 24 hours detention there shall be a minimum free chlorine residual of 25 ppm in all parts of the water pipe. This residual shall then be neutralized in the pipe by injecting an approved reducing agent such as sulfur dioxide, sodium bisulfate, sodium sulfite or sodium thiosulfate.
- E. The Contractor shall perform bacteriological testing on the water service pipe in accordance with the latest revision of AWWA C65. It requires two water samples, taken at least 16 hours apart. The Contractor, with support from the Engineer, is to collect the samples and submit them to a laboratory approved for bacteriological testing. Samples shall be tested for bacteriological quality in accordance with Standard Methods for the Examination of Water and Wastewater, and shall show the absence of coliform bacteria to be considered acceptable. The Contractor shall be responsible for all costs associated with this bacteriological testing and any retesting necessary.

END OF SECTION

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The WORK under this Section includes providing all labor, materials, tools, mobilization, demobilization and equipment necessary for furnishing and installing pipe insulation for the water and sanitary sewer services from the connections to the mains to the mechanical room at the locations shown on the Drawings and as directed by the ENGINEER.

1.3 SUBMITTALS

- A. Rigid board insulation certification and catalogue cut sheet.

PART 2 – PRODUCTS

2.1 RIGID INSULATION

- A. Rigid insulation shall be rigid board closed cell polystyrofoam material containing a flame retardant additive specifically designed for underground pipe or pavement installations, equivalent to Dow Chemical Company Styrofoam HI, and approved by the ENGINEER. Rigid board dimensions shall be 2' wide by 8' long by 2" thick. R Value = 10. Compressive strength = 60 psi.

2.2 SPRAYED-ON INSULATION

- A. Sprayed-on urethane foam insulation applied directly to the pipe exterior with an elastomeric coating, may be approved by the ENGINEER, provided the material has demonstrated a satisfactory performance history in underground installation and has the following physical properties:

Density 2 pcf, Minimum

Compressive Strength 35 psi, Minimum at 5%
(ASTM D 1621) Deflective or Yield

Water Absorption 0.25% by Vol. Maximum
(ASTM C 177)

Thermal Conductivity Max. 0.23 BTU
(ASTM C 177) Hr.Ft.² EF.In. Thickness

PART 3 – EXECUTION

3.1 CONSTRUCTION

- A. The water and sewer service pipes are to be insulated as shown on the Drawings.
- B. Rigid insulation shall be a minimum of 2-feet wide and 2-inches thick. The length of insulation required shall be as shown on the Drawings or as directed by the ENGINEER. Insulation shall be

placed between 6 and 12-inches from the water pipe or service pipe with the width centered on the longitudinal axis of the water pipe or service pipe as shown on the Drawings.

- C. Sprayed-on urethane foam insulation shall be a minimum of 4-inches thick and be installed in strict conformance to the manufacturer's recommendations. Precautions to protect CONTRACTOR personnel, Project inspectors, and the public in general shall be taken by the CONTRACTOR in compliance with OSHA Standards and the manufacturer's recommendations.

END OF SECTION

SECTION 33 31 00 – SANITARY SEWER PIPE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing buried sewer service pipe and fittings, connecting to an existing Haines Borough sewer main, and testing. The CONTRACTOR shall install the sewer pipe to the horizontal and vertical alignment shown on the Drawings and shall complete all associated WORK described in this Section.
- B. This WORK includes furnishings and installing connecting bands, branch connections, elbows or other fittings, and all appurtenances required to complete the sanitary sewer service and connect to the existing sanitary sewer pipe in Union Street.
- C. The vertical and horizontal location of the sewer service shown on the Drawings is based on topographic field survey and record drawings. At least 21 calendar days before scheduled excavation activity to install the sewer service, the CONTRACTOR shall field confirm the sewer main alignment and depth shown on the Drawings. Provide results of these field measurements to the OWNER's Representative within 24 hours of measurement.

1.3 REFERENCES

- A. ASTM International:
 - 1. ASTM A48 – Gray Iron Castings.
 - 2. ASTM A74 – Cast Iron Soil Pipe and Fittings.
 - 3. ASTM A240 – Chromium and Chromium-Nickle Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
 - 4. ASTM A536 – Ductile Iron Castings.
 - 5. ASTM C94 –Ready-Mixed Concrete.
 - 6. ASTM C564 – Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
 - 7. ASTM C923 – Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
 - 8. ASTM D2000 – Standard Classification System for Rubber Products in Automotive Applications.
 - 9. ASTM D3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
 - 10. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

1.4 SUBMITTALS

- A. See Division 01 General Requirements for submittal procedure.
- B. Pre-Construction Submittal:
 - 1. Pipe Testing Method: Provide the leakage test selected; either low-pressure air or hydrostatic exfiltration. Include form to be used for documenting pipe testing. At a minimum the form includes date, time, test personnel, pressure reading, and allowable leakage calculation.

- C. Products:
 - 1. Polyvinyl Chloride (PVC) Pipe.
 - 2. Sewer Service Saddle and restrained harness fitting
 - 3. Sewer Cleanout, fittings, pipe and cast iron frame and lid.
 - 4. Underground Marking Tape.
- D. Test Reports: Completed pipe testing forms.
- E. Manufacturer's Certificate: Certify products submitted meet or exceed requirements.

PART 2 - PRODUCTS

2.1 POLYVINYL CHLORIDE (PVC) GRAVITY SEWER PIPE

- A. PVC pressure pipe shall conform to the applicable requirements of ANSI/AWWA C900 and subject to additional requirements specified herein.
- B. The pipe shall be pressure class 100, and shall be furnished complete with rubber gaskets.
- C. Fittings for PVC pressure pipe shall be cement mortar lined ductile iron in conformance with ANSI A21.4 and shall have an exterior bituminous coating conforming to the requirements of ANSI A21.10.
- D. All joints for the buried PVC pipe shall be either an integral bell manufactured on the pipe or a separate coupling both employing a rubber ring joint. The bell and coupling shall be the same thickness as of the pipe barrel, or greater thickness. The sealing ring groove in the coupling shall be of the same design as the groove in cast iron fittings and valves available from local water works supply distributors.
- E. Flexible water-tight connections, approved by the ENGINEER, shall be used at PVC connections to manholes and other rigid structures.
- F. Connections between PVC Sewer Pipe and PVC Pressure Pipe (PVC (HP)), shall be made with "ROMAC" Stainless Steel Sleeve, or approved equal.

2.2 SEWER CLEANOUT

- A. Sewer cleanout pipe and fittings are to be cast iron hub and spigot service weight conforming to the requirements of ASTM A74 with ASTM C564 gaskets.
- B. Cleanout case and cover, ASTM A48, Class 30 cast iron, H-20 traffic rating, with Sewer CO lettering cast in the cover. Olympic Foundry Part No. M1007 or equal.
- C. Cleanout plug is to be an end of pipe design that will not fall into the pipe. Cherne Industries Part Number 270261 or equal.
- D. Transition coupling to PVC pipe is to be ROMAC Style 501, Ford Meter Box Company Transition Coupling Style FC2A or equal.

2.3 UNDERGROUND MARKING TAPE

- A. Underground marking tape shall be at least four (4) inches wide, four mil thick, polyethylene tape, with a metallic backing capable of being traced with locators. The tape shall have black letters with the following wording: "Caution: Sewer Line Buried Below." The marking tape shall be installed above the sewer pipe as shown on the Drawings. Color: Green.

PART 3 - EXECUTION

3.1 CONSTRUCTION

- A. Excavation, bedding, and backfill shall conform to the requirements of Section 31020 00 EARTHWORK. Underground marking tape shall be installed as shown on the Drawings.
- B. Sheeting and bracing used for trenches shall be removed to the elevation of the pipe, but no sheeting will be allowed to be pulled, removed, or disturbed below the pipe. Sheeting and bracing shall meet OSHA requirements.
- C. Before lowering into the trench, the pipe shall be inspected for defects. All cracked, chipped, or broken pipe shall be discarded. The ends and interior of the pipe shall be clean. Belled ends shall be laid upgrade. Handling of the pipe shall be accomplished in a manner that will not damage the pipe. The joint shall be made in the manner recommended by the manufacturer. Care shall be taken not to buckle or disturb previously laid pipe.
- D. Pipe shall be laid accurately to the staked line and grade as indicated on the Drawings.
- E. Pipe shall be cleaned of all foreign matter, and water shall be kept out of trenches until joints have been completed. When WORK is not in progress, open ends of pipe and fittings shall be securely closed to keep foreign matter and animals from entering.
- F. Each joint shall be inspected to ensure that it is properly made before backfilling is done. Care shall be taken to prevent any dirt or foreign matter from entering the open end of the pipe. Where it is necessary to cut pipe, such cuts shall be neatly made in an approved manner. The laid pipe shall be true to line and grade and, when completed, the sewer shall have a smooth and uniform invert. No section of gravity sewer, including service connections, shall have an adverse grade which would pond water in the invert of the sewer.
- G. Connections to existing sewer mains and manholes shall be made in such a manner so as to not damage the existing facility. Such connections shall be made so that no projections or rough surfaces occur within the pipe.

3.2 TESTING

- A. Prior to testing, the sewer shall be complete, trenches shall be fully backfilled and compacted to finish grade, or, if the sewer is under pavement, finish pavement subgrade. The CONTRACTOR shall provide notes detailing results of the pipe testing.
- B. All sections of pipe shall be tested for leakage using the Exfiltration Test or Filtration Test as specified hereafter. Where leakage is in excess of the specified rate, the sewer shall be repaired by the CONTRACTOR as required to comply with the leakage test requirements. The OWNER's Representative may require the CONTRACTOR to repair obvious leaks even though the total length of the test section falls within the maximum allowable leakage for the test used.
- C. Defective pipe joints shall be repaired in a manner that the repaired pipe joint will have some flexibility and the effectiveness of the repair will not be affected by differential movement of the adjoining pipes. A "CSSI" or DFW/HPI non-shear coupling, or approved equal, will be acceptable in making such repairs.
- D. Check each run of pipeline for gross alignment deficiencies by holding a light in a manhole or accessible end of pipe; there shall be a practically full circle of light through the pipeline when viewed from the adjoining end of line.

- E. The OWNER's Representative will make one complete TV inspection after all sewers have passed the specified watertightness test. All defects regarding sewer alignment and grade, damaged pipe, and visible leaks observed during this inspection, shall be corrected by the CONTRACTOR. The CONTRACTOR shall de-water the sewers as required for the performance of the TV inspection work by the OWNER's Representative. The CONTRACTOR shall be responsible for all costs associated with any TV inspection required following the initial TV inspection, if any defects were observed during this or any subsequent TV inspections.

3.3 EXFILTRATION TEST (USING WATER)

- A. Where groundwater is below the pipe to be tested, a minimum of head of eight feet of water above the crown at the upper end of the test section shall be maintained for a period of four hours, during which time it will be presumed that full absorption of the pipe body has taken place, and thereafter for a further period of one hour for the actual test of leakage. During this one hour period, the measured loss shall not exceed the rate given below:

Type of Pipe	Allowable Exfiltration Rate
PVC	$E = 0.0004 \text{ DL}$

E = Allowable leakage in gallons per hour
 D = Nominal inside diameter of pipe in inches
 L = Length of pipe being tested in feet

- B. Where groundwater is above any pipe to be tested, the minimum head of the test will be raised to provide an elevation head of eight feet above the groundwater.
- C. The maximum length of sewer in any test section shall be 500 feet.

3.4 FILTRATION TEST (USING AIR)

- A. The CONTRACTOR shall furnish all facilities and personnel for conducting the test under the observation of the ENGINEER. The equipment and personnel shall be subject to the approval of the ENGINEER. Joints only may be tested in pipe 36 inches in diameter or larger, at the option of the CONTRACTOR.
- B. Immediately following the pipe cleaning, the pipe installation shall be tested with low pressure air. Air shall be slowly supplied to the plugged pipe installation until the internal air pressure reaches five pounds per square inch greater than the average back pressure of any ground water that may submerge the pipe. At least two minutes shall be allowed for temperature stabilization before proceeding further.
- C. The pipeline shall be considered acceptable when tested at an average pressure of four psi greater than the average pressure of any ground water that may submerge the pipe if the section under test does not lose air at a rate greater than 0.0030 cubic feet per minute per square foot of internal surface.
- D. The requirements of this Specification shall be considered satisfied if the time required for the pressure to decrease from 4.5 psi to 3.5 psi above average ground water pressure is greater than the test time obtained using the following formula:

$$T = 28.33 D$$

Where T = time in seconds

D = pipe diameter in inches

- E. Pressure gauges should be incremented in not more than one-half pound increments for accurate tests.
- F. Braces shall be required to hold plugs in place and to prevent the sudden release of the compressed air. Due to the large forces that could be exerted by an escaping plug during the testing of the pipe, no one shall be allowed in the manholes in which plugs have been placed while tests are being conducted. The CONTRACTOR's testing equipment shall have a pressure relief device that will prohibit the pressure in the pipeline from exceeding ten pounds per square inch.

END OF SECTION

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SECTION 33 41 00 - STORM SEWER PIPE

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. The WORK under this Section includes providing all labor, materials, tools and equipment necessary for furnishing and installing pipe culverts in accordance with these Specifications and in reasonably close conformity with the lines and grades shown on the Drawings or as directed by the ENGINEER.
- B. This WORK also includes furnishing and installing connecting bands, branch connections, elbows and end sections required to complete the culvert as shown on the Drawings.

1.03 SUBMITTALS

- A. Storm Sewer Pipe: Material certifications stating conformance with requirements of this section and manufacturer's catalog cuts of pipe materials and fittings.

PART 2 – PRODUCTS

2.01 CORRUGATED POLYETHYLENE PIPE

- A. Corrugated polyethylene pipe (CPP) shall be high density corrugated polyethylene, smooth interior pipe, and shall be manufactured in conformity with the latest AASHTO M 294, Type S specification, and shall meet the requirements of ASTM D 3350 Cell Classification 324420C, or ASTM D 1248, Class C, Category 4, Grade P33.
- B. Pipe shall be joined with "Hancor, Inc. Hi-Q Sure-Lok" (bell-and-spigot) joint, or approved equal, meeting the requirements of AASHTO M 294. The bell shall be an integral part of the pipe and provide a minimum pull-apart strength of 400 pounds.
- C. The bell-and-spigot joint shall incorporate a gasket making it silt-tight. Gaskets shall be installed in the bell, or on the pipe, by the pipe manufacturer.
- D. Fittings shall conform to AASHTO M 294. Fabricated fittings shall be welded on the interior and exterior at all junctions. All fittings shall connect to the pipe with a bell and spigot joint.
- E. All cut corrugations on CPP pipe shall be cleared of all water and completely grouted to prevent the accumulation of water.

2.02 UNDERGROUND MARKING TAPE

- A. Underground Marking Tape shall be yellow, at least 4-inches wide, 4-mil thick, polyethylene tape with a metallic backing capable of being traced with locators. The tape shall have black letters with the following wording: "Caution: Storm Sewer Line Buried Below", or similar. The marking tape shall be installed 12-inches above the top of all storm sewer mains and services.

PART 3 – EXECUTION

3.01 CONSTRUCTION

- A. Excavation, Bedding, and Backfill shall conform to the requirements of Section 312317 – Trenching. All pipe shall have a minimum cover of 12 inches, unless otherwise shown on the Drawings or directed by the ENGINEER.
- B. The pipe laying shall begin at the downstream end of the pipe. The lower segment of the pipe shall be in contact with the shaped bedding throughout its full length. Bell or groove ends of rigid pipe and outside circumferential laps of flexible pipe shall be placed facing upstream.
- C. Joints shall be made with rubber gaskets.
- D. Flexible conduits shall be firmly joined by approved coupling bands.
- E. Conduit shall be inspected before any backfill is placed. Any pipe found to be substantially out of alignment, unduly settled, or damaged shall be taken up and relaid or replaced.
- F. Installation of all pipes shall conform to the manufacturer's recommended procedures. These Specifications and the Drawings shall take precedence over the manufacturer's recommendations in the event of conflict, if more restrictive.
- G. Pipe culvert shall be installed as shown on the Drawings, unless otherwise directed by the ENGINEER. All bends, couplings and other fittings necessary to connect to existing pipes or flows shall be approved by the ENGINEER.
- H. All cut corrugations on CPP pipe shall be cleared of all water and completely grouted to prevent the accumulation of water.

END OF SECTION