



UAPB Health & Allied Sciences Building

100% CONSTRUCTION DOCUMENTS

PROJECT MANUAL

August 31, 2026



AMR Architects, Inc.

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**SECTION 000107
SEALS PAGE**

THE ARCHITECT OF RECORD FOR UAPB HEALTH & ALLIED SCIENCES BUILDING IS:

AMR Architects, Inc.



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SECTION 012100 ALLOWANCES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Cash allowances.

1.02 RELATED REQUIREMENTS

- A. Section 012000 - Price and Payment Procedures: Additional payment and modification procedures.

1.03 CASH ALLOWANCES

- A. Costs Included in Cash Allowances: Cost of product to Contractor or subcontractor, less applicable trade discounts .
- B. Architect Responsibilities:
 - 1. Consult with Contractor for consideration and selection of products, suppliers , and installers.
 - 2. Select products in consultation with Owner and transmit decision to Contractor.
- C. Contractor Responsibilities:
 - 1. Assist Architect in selection of products, suppliers , and installers.
 - 2. Obtain proposals from suppliers and installers and offer recommendations.
 - 3. On notification of which products have been selected, execute purchase agreement with designated supplier and installer.
 - 4. Arrange for and process shop drawings, product data, and samples. Arrange for delivery.
 - 5. Promptly inspect products upon delivery for completeness, damage, and defects. Submit claims for transportation damage.
- D. Differences in costs will be adjusted by Change Order.

1.04 ALLOWANCES SCHEDULE

- A. Allowance #1 - Allow \$10,000 for **Interior Signage**
- B. Allowance #2 - Allow \$10,000 for **Exterior Signage**

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION 012100

**SECTION 033543
POLISHED CONCRETE**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Polished concrete system.
- B. Surface treatments for concrete floors and slabs.
- C. Densifiers and hardeners.
- D. Coatings.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Finishing of concrete surface; curing.
- B. Section 079200 - Joint Sealants.

1.03 ABBREVIATIONS AND ACRONYMS

- A. CPC: Concrete Polishing Council.

1.04 REFERENCE STANDARDS

- A. ANSI/NFSI B101.1 - Test Method for Measuring the Wet SCOF of Hard-Surface Walkways; 2022.
- B. ANSI/NFSI B101.3 - Test Method for Measuring the Wet DCOF of Hard Surface Walkways; 2022.
- C. ASTM C1353/C1353M - Standard Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser; 2020, with Editorial Revision.
- D. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Coating Systems; 2020 (Reapproved 2025).
- E. ASTM D4039 - Standard Test Method for Reflection Haze of High-Gloss Surfaces; 2009 (Reapproved 2023).
- F. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers; 2022.
- G. ASTM D5767 - Standard Test Method for Instrumental Measurement of Distinctness-of-Image (DOI) Gloss of Coated Surfaces; 2018 (Reapproved 2023).
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials; 2024a.
- I. ASTM G154 - Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials; 2023.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate work of this section with concrete floor placement and concrete floor curing.
- B. Preinstallation Meeting: Conduct a preinstallation meeting 10 days prior to start of work of this section.
 - 1. Items for Review:
 - a. Physical requirements of completed concrete slab and slab finish.
 - b. Location and timing of test areas.
 - c. Protection of surfaces not scheduled for finish application.
 - d. Surface preparation.
 - e. Application procedure and quality control.
 - f. Cleaning and protection of finish.
 - g. Coordination with other work.
 - 2. Require attendance of parties directly affecting work of this section, including:
 - a. Concrete installer.

- b. Finish installer.
 - c. Contractor's representative.
 - d. Architect.
 - e. Owner's representative.
- 3. Notify parties one week in advance of date and time of meeting.

1.06 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's published data on each finishing product, including information on compatibility of different products and limitations.
- C. Product Data: Manufacturer's published data and installation instructions for concrete polishing system and finishing products, including manufacturer's installation instructions, information on compatibility of different products, and limitations.
- D. Maintenance Data: Provide data on maintenance and renewal of applied finishes.
- E. Installer's qualification statement.
- F. Executed warranty.
- G. Floor protection plan.

1.07 QUALITY ASSURANCE

- A. Comply with national, state, and local VOC regulations.
- B. Installer Qualifications:
 - 1. Company specializing in installing products specified in this section, having completed minimum of five projects of similar size and complexity.
 - 2. Company is listed applicator of concrete finishes, having completed manufacturer's training program.

1.08 MOCK-UP

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. For coatings, construct mock-up area under conditions similar to those that will exist during application, with coatings applied.
- C. Mock-Up Size: 150 sq ft.
- D. Locate on site where directed.
- E. Accepted mock-up panel is considered basis of quality for the finished work. Keep mock-up exposed to view for duration of concrete work.
- F. Mock-up may remain as part of work.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's sealed packaging, including application instructions.
- B. Store materials per manufacturer's product data sheets:
 - 1. Store containers upright in cool, dry, well-ventilated place, out of the sun, at temperature between 40 degrees F and 100 degrees F.
 - 2. Protect from freezing.
 - 3. Store away from other chemicals and potential sources of contamination.
 - 4. Keep lights, fire, sparks, and heat away from container.
 - 5. Do not drop containers or slide across sharp objects.
 - 6. Do not stack pallets more than three high.
 - 7. Keep containers tightly closed when not in use.

1.10 FIELD CONDITIONS

- A. Ambient Conditions:

1. Apply treatments and coatings when surface and air temperature is between 40 degrees F and 95 degrees F.
2. Apply treatments and coatings when surface and air temperature is expected to remain above 40 degrees F for a minimum of eight hours after application.
3. Maintain ambient temperature of 50 degrees F minimum.
4. Apply treatments and coatings during calm wind conditions; provide adequate ventilation of enclosed or confined area.
5. Apply treatments and coatings minimum 24 hours after rain exposure; suspend application when rain is anticipated within 8 hours of application.
6. Do not apply to frozen substrate.

1.11 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

PART 2 PRODUCTS

2.01 POLISHED CONCRETE SYSTEM

- A. Polished Concrete System: Materials, equipment, and procedures designed and furnished by a single manufacturer to produce dense polished concrete of the specified sheen.
 1. Manufacturer:
 - a. L & M Construction Chemicals, Inc.
 - b. Ameripolish
 - c. Advanced Floor Products
 - d. Prosoco
 - e. Or Approved Equal.
 2. Substitutions: See Section 016000 - Product Requirements.

2.02 DENSIFIERS AND HARDENERS

- A. Liquid Densifier and Hardener: Penetrating chemical compound, reacts with concrete, filling pores, hardening, and dustproofing, including highly polished concrete floors.
 1. Composition: Lithium silicate.
 2. Abrasion Resistance: Greater than 50 percent improvement compared to untreated sample in accordance with ASTM C1353/C1353M.
 3. Treated Material Slip Resistance: High traction range when tested according to ANSI/NFSI B101.1 and ANSI/NFSI B101.3.
 4. Adhesion: Greater than 10 percent increase in pull-off strength compared to untreated sample when tested according to ASTM D4541.
 5. Water Vapor Transmission: Zero perms compared to untreated sample when tested according to ASTM E96/E96M Method B.
 6. UV Stability: No degradation or yellowing when tested in accordance with ASTM G154.
 7. Product:
 - a. PROSOCO, Inc; Consolideck LS: www.prosoco.com/consolideck/#sle.
 - b. Ameripolish; 3D HSRetroplate
 - c. Advanced Floor Products; 99

2.03 COATINGS

- A. Coatings, General:
 1. Treated Material Slip Resistance: High traction range when tested according to ANSI/NFSI B101.1 and ANSI/NFSI B101.3.
 2. Stain Resistance: No adverse effect when tested according to ASTM D1308.
 3. UV Stability: No degradation or yellowing when tested according to ASTM G154.
- B. Clear Coating:
 1. Stain Guard Sealer- L & M Construction Chemicals, Permagaard SPS
 - a. Composition: Lithium silicate.

- b. Adhesion: Greater than 10 percent increase in pull off strength compared to untreated sample when tested according to ASTM D4541.
- c. Product:
 - 1) PROSOCO, Inc; Consolideck LSGuard: www.prosoco.com/consolideck/#sle.
 - 2) Ameripolish; SureLock Stain Protector
 - 3) Advanced Floor Products; RetroGaurd 99

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that floor surfaces are clean and free of previous coatings, sealers, curing compounds, water repellents, laitance, efflorescence, fats, oils, grease, wax, soluble salts, residues from cleaning agents, and other impediments to adhesion.
- B. Verify that flaws in concrete have been patched and joints filled with methods and materials suitable for further finishes and allow complete curing before application of concrete hardener and densifier. See Section 079200.

3.02 GENERAL

- A. Apply materials in accordance with manufacturer's instructions.

3.03 CURING OF CONCRETE SLAB

- A. See Section 033000.

3.04 PREPARATION

- A. Protect adjacent non-coated areas from drips, overflow, and overspray; avoid contact with metal, glass, and painted surfaces; immediately remove excess material.
- B. Correct variations in slab texture and color prior to application of hardener-densifier.

3.05 CONCRETE POLISHING

- A. Grind and polish in multiple passes with each full pass in direction perpendicular to previous pass.
- B. Fill gaps, voids, and pop-outs during grinding operation.
- C. Apply densifier and hardener at specified rates and intervals.
- D. Final Polished Concrete Aggregate Exposure: Not to exceed CPC Class C - Coarse Aggregate; coarse aggregate and cement fines, 80 percent; fine aggregate and cement fines blend, 10 to 20 percent based on visual observation of overall area of polished floor versus Polished Concrete Aggregate Exposure Chart. **Intent is to match appearance of polished concrete in Lobby of adjacent Student Engagement Center**
- E. Final Polished Concrete Appearance: CPC Level 2 - Satin, image clarity value 10 to 39 percent with haze index less than 10.

3.06 PROTECTIVE TREATMENT

- A. Apply coatings in accordance with manufacturer's instructions. Match approved mock-ups for color, texture, sealing, and workmanship.
- B. Apply manufacturer's recommended protective treatment material to clean, dry slab after mechanically polishing.
 - 1. High gloss protective treatment:
 - a. Stop spreading treatment material when drying begins.
 - b. Avoid overlapping treatment material.
 - c. Allow to dry tack-free before burnishing slab surface in accordance with manufacturer's recommendations.
 - d. Repeat treatment up to three coats.
 - 2. Medium gloss protective treatment:
 - a. Stop spreading treatment material when drying begins.
 - b. Avoid overlapping treatment material.

- c. Repeat treatment up to two coats.
 - d. For increased gloss, allow final coat to dry before burnishing slab surface in accordance with manufacturer's recommendations.
- 3. Low gloss protective treatment:
 - a. Allow to dry tack-free before burnishing slab surface in accordance with manufacturer's recommendations.
 - b. Repeat treatment up to two coats.
 - c. For reduced haze, allow final coat to dry before burnishing slab surface in accordance with manufacturer's recommendations.
- 4. No gloss protective treatment: Do not burnish slab.
- C. Clean spills on slab surfaces immediately, with manufacturer's recommended chemicals and absorptive materials.
- D. No haze, white residue, streaking, or burnish marks permitted.

3.07 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Defective Concrete: Repair or replace concrete not complying with required lines, details, dimensions, tolerances, or specified requirements at no additional cost to Owner.
- C. Final Polished Concrete Appearance: Test image clarity value and haze index prior to application of sealer at a rate of three tests per 1000 sq ft of polished concrete.
 - 1. Image clarity: Test with Image Clarity Meter in accordance with ASTM D5767.
 - 2. Haze index: Test with Glossmeter in accordance with ASTM D4039.
 - 3. Match approved mock-ups for texture, appearance, and workmanship.

3.08 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION 033543

SECTION 042000 UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Clay facing brick.
- B. Mortar and grout.
- C. Reinforcement and anchorage.
- D. Flashings.
- E. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 032000 - Concrete Reinforcing: Reinforcing steel for grouted masonry.
- B. Section 055000 - Metal Fabrications: Loose steel lintels.
- C. Section 061000 - Rough Carpentry: Nailing strips built into masonry.
- D. Section 072100 - Thermal Insulation: Insulation for cavity spaces.
- E. Section 076200 - Sheet Metal Flashing and Trim: Through-wall masonry flashings.
- F. Section 079200 - Joint Sealants: Sealing control and expansion joints.

1.03 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications; 2026.
- C. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2019.
- D. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- E. ASTM A951/A951M - Standard Specification for Steel Wire for Masonry Joint Reinforcement; 2026.
- F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2024.
- G. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction; 2022.
- H. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar; 2026.
- I. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
- J. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2024.
- K. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale); 2026a.
- L. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2026.
- M. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2026.
- N. ASTM C476 - Standard Specification for Grout for Masonry; 2023.
- O. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2024.
- P. ASTM D4637/D4637M - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane; 2015, with Editorial Revision (2022).

- Q. ASTM E154/E154M - Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover; 2008a (Reapproved 2025).
- R. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing; 2017.
- S. BIA Technical Notes No. 13 - Ceramic Glazed Brick Exterior Walls; 2017.
- T. BIA Technical Notes No. 28B - Brick Veneer/Cold-Formed Steel Framed Walls; 2025.
- U. BIA Technical Notes No. 46 - Maintenance of Brick Masonry; 2017.
- V. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures; 2022, with Errata (2024).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
- C. Samples: Submit four samples of facing brick units to illustrate color, texture, and extremes of color range.
- D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- E. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.
- F. Test Reports: Concrete masonry manufacturer's test reports for units with integral water repellent admixture.
- G. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, telephone numbers, names of Architects and Owners, and other information specified.
- H. Hot-weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.
- I. Cold-weather construction procedures evidencing compliance with requirements specified in referenced unit masonry standard.

1.05 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.
- B. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one manufacturer for each different product required for each continuous surface or visually related surfaces.
- C. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source and producer for each aggregate.
- D. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.
- E. Protection of Masonry: During erection, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
 - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

1.06 MOCK-UPS

- A. Construct a masonry wall as a mock-up panel sized 4 feet long by 4 feet high; include mortar, accessories, and flashings (with lap joint, corner, and end dam) in mock-up.
- B. Locate where directed.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
- B. Store cementitious materials off the ground, under cover, and in dry location. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

PART 2 PRODUCTS

2.01 CLAY MASONRY UNITS

- A. General
 - 1. Comply with referenced unit masonry standard and other requirements specified in this Section applicable to each material indicated.
 - 2. Provide units without cores or frogs and with all exposed surfaces finished for ends of sills, caps, and similar applications that expose brick surfaces that otherwise would be concealed from view.
- B. Manufacturers:
 - 1. ACME: Sierra - Modular - Velour.
 - 2. Substitutions: See section 016000 - Product Requirements.
- C. Facing Brick: ASTM C216, Type FBX, Grade SW.
 - 1. Color and texture as noted on Drawing **EXTERIOR MATERIAL LEGEND**
 - 2. Standard size: 3-5/8 inches thick by 2-1/4 inches high by 7-5/8 inches long.
 - 3. Special shapes: Molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect.

2.02 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
 - 1. Not more than 0.60 percent alkali.
 - 2. except Type III may be used for cold-weather construction.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Mortar Aggregate: ASTM C144. except for joints less than 1/4 inch use aggregate graded with 100 percent passing the No. 16 sieve.
- D. Grout Aggregate: ASTM C404.
- E. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
 - 1. Color(s): As selected by Architect from manufacturer's full range.
- F. Water: Clean and potable.

2.03 REINFORCEMENT AND ANCHORAGE

- A. General:
 - 1. Provide ties and anchors specified in subsequent articles that comply with requirements for metal and size of referenced unit masonry standard and of this article.
 - 2. Galvanized Carbon Steel Wire: ASTM A 82, coating class as required by referenced unit masonry standard for application indicated.
 - a. Wire Diameter: 3/16 inch

3. Galvanized Steel Sheet: As follows:
 - a. ASTM A 526 (commercial quality), Coating Designation G60, steel sheet zinc-coated by hot-dip process on continuous lines prior to fabrication, for sheet metal ties and anchors completely embedded in mortar.
 - b. ASTM A 366 (commercial quality) cold-rolled carbon steel sheet hot-dip galvanized after fabrication to comply with ASTM A 153, Class B2 (for unit lengths over 15 inches) and Class B3 (for unit lengths under 15 inches), for sheet metal ties and anchors exposed to the weather and not completely embedded in mortar and grout.
 - c. Thickness of Steel Sheet Galvanized After Fabrication: Uncoated thickness of steel sheet hot-dip galvanized after fabrication:
 - 1) 0.1046 inch (12 gage).
- B. Manufacturers:
 1. Blok-Lok Limited: www.blok-lok.com/#sle.
 2. Hohmann & Barnard, Inc; X-Seal Anchor: www.h-b.com/#sle.
 3. TruFast Walls, a division of Altenloh, Brinck & Co. US, Inc; Thermal-Grip MVA: www.trufastwalls.com/#sle.
 4. AA Wire Products Co.
 5. Dur-O-Wal, Inc.
 6. Heckman Building Products, Inc. Hohmann & Barnard, Inc.
 7. Masonry Reinforcing Corp. of America.
 8. National Wire Products Industries.
 9. Substitutions: See Section 016000 - Product Requirements.
- C. Joint Reinforcement: Provide joint reinforcement complying with requirements of referenced unit masonry standard and per Structural drawings.
- D. Single Wythe Joint Reinforcement: ASTM A951/A951M.
 1. Type: Truss or ladder.
 2. Material: ASTM A1064/A1064M steel wire, mill galvanized to ASTM A641/A641M Class 3.
- E. Strap Anchors: Bent steel shapes, 1-1/2 inch width, 0.105 inch thick, 24 inch length, with 1-1/2 inch long, 90 degree bend at each end to form a U or Z shape or with cross pins, hot dip galvanized to ASTM A153/A153M Class B.
- F. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not less than 5/8 inch of mortar coverage from masonry face.
- G. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
 1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
 2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
 3. Vertical adjustment: Not less than 3-1/2 inches.

2.04 FLASHINGS

- A. Metal Flashing Materials:
 1. Copper Flashing: ASTM B370, 060 soft annealed; 20 oz/sq ft thick; natural finish.
 2. Stainless Steel Flashing: ASTM A666/A666M, Type 304, soft temper; 26 gauge, 0.0187 inch thick; finish 2B to 2D.
 3. Prefabricated Metal Flashing: Smooth fabricated 12 oz/sq ft copper flashing for surface mounted conditions.
 - a. Manufacturers:
 - 1) Cheney Flashing Company: www.cheneyflashing.com/#sle.
 - 2) Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - 3) Substitutions: See Section 016000 - Product Requirements.

- B. Combination Asphaltic Flashing Materials - Copper:
 - 1. Copper/Asphalt Flashing: 3 oz/sq ft copper sheet coated with elastic asphalt compound on both sides.
- C. Combination Nonasphaltic Flashing Materials - Copper:
 - 1. Copper/Polymer Film or Fabric Flashing: 3 oz/sq ft copper sheet laminated between two sheets of polyethylene film. Minimum Puncture Resistance of 780 psi, when measured in accordance with ASTM E154/E154M.
- D. Combination Non-Asphaltic Flashing Materials - Stainless Steel:
 - 1. Stainless Steel Flashing - Self-adhering: ASTM A240/A240M; 2 mil type 304 stainless steel sheet with 8 mil of butyl adhesive and a removable release liner.
- E. Membrane Non-Asphaltic Flashing Materials:
 - 1. EPDM Flashing: ASTM D4637/D4637M, Type I, 0.040 inch thick.
 - a. Manufacturers:
 - 1) Elevate; Enverge FlashGard Thru-Wall Flashing: www.holcimelevate.com/#sle.
 - 2) Heckmann Building Products, Inc: www.heckmannbuildingprods.com/#sle
 - 3) Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - 4) WIRE-BOND: www.wirebond.com/#sle.
 - 5) Substitutions: See Section 016000 - Product Requirements.
- F. Factory-Fabricated Flashing Corners and End Dams: Stainless steel.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - b. Mortar Net Solutions; CompleteFlash: www.mortarnet.com/#sle.
 - c. York Flashings: www.yorkflashings.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- G. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.
 - 1. Manufacturers, Synthetic Rubber Products:
 - a. Mortar Net Solutions; BTL-1 Butyl Sealant: www.mortarnet.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
 - 2. Manufacturers, Modified Polyether Products:
 - a. Mortar Net Solutions: www.mortarnet.com/#sle.
 - b. York Flashings; UniverSeal US-100 Liquid Tape: www.yorkflashings.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- H. Termination Bars: Stainless steel; compatible with membrane and adhesives.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - b. Mortar Net Solutions; Termination Bars: www.mortarnet.com/#sle.
 - c. York Flashings; Termination Bar: www.yorkflashings.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- I. Drip Edge: Stainless steel; angled drip with hemmed edge; compatible with membrane and adhesives.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - b. Mortar Net Solutions; Metal Drip Edges: www.mortarnet.com/#sle.
 - c. York Manufacturing, Inc: www.yorkmfg.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- J. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.05 ACCESSORIES

- A. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
 - 1. Manufacturers:
 - a. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - b. WIRE-BOND: www.wirebond.com/#sle.
- B. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
 - 1. Full-Height Airspace Maintenance and Drainage Material: Mesh panels fitted between masonry ties.
 - a. Drainage Material Thickness: 3/8 inch.
 - b. Manufacturers:
 - 1) Advanced Building Products, Inc; Mortairvent-CW: www.advancedbuildingproducts.com/#sle.
 - 2) CavClear, a Division of Archovations Inc; CavClear Masonry Mat: www.cavclear.com/#sle.
 - 3) Substitutions: See Section 016000 - Product Requirements.
- C. Weeps:
 - 1. Type: Polyester mesh.
 - 2. Color(s): As selected by Architect from manufacturer's full range.
 - 3. Manufacturers:
 - a. Advanced Building Products, Inc: www.advancedbuildingproducts.com/#sle.
 - b. Blok-Lok Limited: www.blok-lok.com/#sle.
 - c. Mortar Net Solutions: www.mortarnet.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.
- D. Cavity Vents:
 - 1. Type: Polyester mesh.
 - 2. Color(s): As selected by Architect from manufacturer's full range.
 - 3. Manufacturers:
 - a. Advanced Building Products, Inc: www.advancedbuildingproducts.com/#sle.
 - b. Blok-Lok Limited: www.blok-lok.com/#sle.
 - c. CavClear, a Division of Archovations Inc: www.cavclear.com/#sle.
 - d. Hohmann & Barnard, Inc: www.h-b.com/#sle.
 - e. Mortar Net Solutions: www.mortarnet.com/#sle.
 - f. WIRE-BOND: www.wirebond.com/#sle.
 - g. Substitutions: See Section 016000 - Product Requirements.
- E. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.06 MORTAR AND GROUT MIXING

- A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.
 - 1. Masonry below grade and in contact with earth: Type S.
 - 2. Exterior, loadbearing masonry: Type N.
 - 3. Exterior, non-loadbearing masonry: Type N.
 - 4. Interior, loadbearing masonry: Type N.
 - 5. Interior, non-loadbearing masonry: Type O.
- B. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
- C. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.

- D. Mixing: Use mechanical batch mixer and comply with referenced standards.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

3.02 COLD AND HOT WEATHER REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
- B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

3.03 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.
- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Brick Units:
 - 1. Bond: Running.
 - 2. Coursing: Three units and three mortar joints to equal 8 inches.
 - 3. Mortar Joints: As indicated in drawings.

3.04 PLACING AND BONDING

- A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Remove excess mortar and mortar smears as work progresses.
- D. Interlock intersections and external corners.
- E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- F. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.05 WEEPS/CAVITY VENTS

- A. Install weeps in veneer and cavity walls at 24 inches on center horizontally on top of through-wall flashing above shelf angles and lintels and at bottom of walls.
- B. Install cavity vents in veneer and cavity walls at 32 inches on center horizontally below shelf angles and lintels and near top of walls.

3.06 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.07 REINFORCEMENT AND ANCHORAGE - GENERAL AND CAVITY WALL MASONRY

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Lap joint reinforcement ends minimum 6 inches.

- D. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches on center.
- E. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches horizontally and 24 inches vertically.
- F. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.

3.08 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Masonry Back-Up: Embed anchors to bond veneer at maximum 16 inches on center vertically and 36 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.
- B. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 24 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

3.09 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
 - 1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 1 inch, minimum, to form watertight pan at nonmasonry construction.
 - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
 - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Terminate flashing up 8 inches minimum on vertical surface of backing:
 - 1. Install vertical leg of flashing behind water-resistive barrier sheet over backing.
 - 2. Install vertical leg of flashing over fluid-applied or self-adhered air/vapor barriers over backing or per manufacturer's directions.
 - 3. Terminate vertical leg of flashing into bed joint in masonry or reglet in concrete.
 - 4. Anchor vertical leg of flashing into backing with a termination bar and sealant.
 - 5. Apply cap bead of sealant on top edge of self-adhered flashing.
- C. Install flashing in accordance with manufacturer's instructions and BIA Technical Notes No. 7.
- D. Extend metal flashings to within 1/2 inch of exterior face of masonry and adhere to top of stainless steel angled drip with hemmed edge.
- E. Support flexible flashings across gaps and openings.
- F. Extend plastic and EPDM flashings to within 1/2 inch of exterior face of masonry and adhere to top of stainless steel angled drip with hemmed edge.
- G. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

3.10 LINTELS

- A. Install loose steel lintels over openings. See Structural Drawings for schedule.

3.11 GROUTED COMPONENTS

- A. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
- B. Place and consolidate grout fill without displacing reinforcing.
- C. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.12 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Form expansion joint as detailed on drawings.

3.13 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and glazed frames and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door and glazed frames in adjacent mortar joints. Fill frame voids solid with grout.
 - 1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

3.14 TOLERANCES

- A. Install masonry within the site tolerances found in TMS 402/602.
- B. Maximum Variation from Alignment of Columns: 1/4 inch.
- C. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- D. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- E. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- F. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- G. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.
- H. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.15 CUTTING AND FITTING

- A. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.16 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Clean soiled surfaces with cleaning solution.

3.17 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION 042000

**SECTION 055000
METAL FABRICATIONS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Shop fabricated steel and aluminum items.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- B. Section 042000 - Unit Masonry: Placement of metal fabrications in masonry.
- C. Section 051200 - Structural Steel Framing: Structural steel column anchor bolts.
- D. Section 052100 - Steel Joist Framing: Structural joist bearing plates, including anchorage.
- E. Section 053100 - Steel Decking: Bearing plates for metal deck bearing, including anchorage.
- F. Section 055133 - Metal Ladders.
- G. Section 055213 - Metal Railings.
- H. Section 099000 - Painting: Field paint finish.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- B. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2024.
- D. ASTM A283/A283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2024.
- E. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- F. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.
- H. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings; 2025.
- I. ASTM B85/B85M - Standard Specification for Aluminum-Alloy Die Castings; 2025.
- J. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- K. ASTM B210/B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2026.
- L. ASTM B211/B211M - Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire; 2023.
- M. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- N. ASTM F3125/F3125M - Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi, 144 ksi, and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength; 2026.
- O. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- P. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2026.

- Q. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
- R. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; 2014, with Errata (2020).
- S. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019, with Editorial Revision (2025).
- T. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer; 2004.
- U. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- V. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- D. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172.

1.05 QUALITY ASSURANCE

- A. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.2/D1.2M and dated no more than 12 months before start of scheduled welding work.
- B. Fabricator Qualifications: A qualified steel fabricator that is accredited by IAS AC172.

PART 2 PRODUCTS

2.01 MATERIALS - STEEL

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A501/A501M hot-formed structural tubing.
- C. Plates: ASTM A283/A283M.
- D. Pipe: ASTM A53/A53M, Grade B Schedule 40, hot-dip galvanized finish.
- E. Slotted Channel Fittings: ASTM A1011/A1011M.
- F. Mechanical Fasteners: Same material as or compatible with materials being fastened; type consistent with design and specified quality level.
- G. Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.
- H. Bolts, Nuts, and Washers: ASTM F3125/F3125M, Type 1, plain.
- I. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- J. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- K. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.02 MATERIALS - ALUMINUM

- A. Extruded Aluminum: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B209/B209M, 5052 alloy, H32 or H22 temper.
- C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210/B210M, 6063 alloy, T6 temper.
- D. Aluminum-Alloy Bars: ASTM B211/B211M, 6061 alloy, T6 temper.

- E. Aluminum-Alloy Sand Castings: ASTM B26/B26M.
- F. Aluminum-Alloy Die Castings: ASTM B85/B85M.
- G. Bolts, Nuts, and Washers: Stainless steel.
- H. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

2.03 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by intermittent welds and plastic filler.
- D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.
- F. Furnish components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.04 FABRICATED ITEMS

- A. Bollards: Steel pipe, concrete filled, crowned cap, as detailed; prime paint finish.
- B. Joist Hangers: Strap anchors, fabricated with sheet steel, 18 gauge, 0.0478 inch minimum base metal thickness; galvanized finish.
- C. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to Structural Framing: For support of metal decking; galvanized finish.
- D. Lintels: As detailed; galvanized finish.
- E. Door Frames for Overhead Door Openings and Wall Openings: Channel and Angle sections; galvanized finish.
- F. Recessed Mat Frames : As detailed; steel, galvanized finish.
- G. Elevator Hoistway Divider Beams: Beam sections; prime paint finish.
- H. Toilet Partition Suspension Members: Aluminum channel sections; mill finish.
- I. Slotted Channel Framing: Fabricate channels and fittings from structural steel complying with the referenced standards; factory-applied, rust-inhibiting thermoset acrylic enamel finish.

2.05 FINISHES - STEEL

- A. Prime paint steel items.
 - 1. Exceptions: Galvanize items to be embedded in concrete and items to be embedded in masonry, or items to be exposed to the exterior
 - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Prime Painting: Two coats.
- E. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A123/A123M requirements. Provide minimum 1.7 oz/sq ft galvanized coating.
- F. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A123/A123M requirements.

2.06 FINISHES - ALUMINUM

- A. Exterior Aluminum Surfaces: Class I color anodized.

- B. Interior Aluminum Surfaces: Class I color anodized.

2.07 FABRICATION TOLERANCES

- A. Squareness: 1/8 inch maximum difference in diagonal measurements.
- B. Maximum Offset Between Faces: 1/16 inch.
- C. Maximum Misalignment of Adjacent Members: 1/16 inch.
- D. Maximum Bow: 1/8 inch in 48 inches.
- E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Furnish setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.

3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components as indicated on drawings.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed , except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 055000

SECTION 055100 METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Stairs with concrete treads.
- B. Prefabricated stairs.
- C. Structural steel stair framing and supports.
- D. Handrails and guards.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Concrete fill in stair pans; mesh reinforcement for landings.
- B. Section 033000 - Cast-in-Place Concrete: Placement of metal anchors in concrete.
- C. Section 042000 - Unit Masonry: Placement of metal fabrications in masonry.
- D. Section 055000 - Metal Fabrications.
- E. Section 099000 - Painting: Paint finish.

1.03 REFERENCE STANDARDS

- A. AISC 207 - Standard for Certification Programs; 2025.
- B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- C. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- D. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- E. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.
- H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- J. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- K. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2026.
- L. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
- M. SSPC-SP 2 - Hand Tool Cleaning; 2024.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide Alternating Stair product data and cut sheet indicating conformance with design intent..
- C. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.

1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- D. Design Data: As required by authorities having jurisdiction.
- E. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated no more than 12 months before start of scheduled welding work.
- F. Designer's Qualification Statement.
- G. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is certified under AISC 207.

1.05 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in Arkansas, or personnel under direct supervision of such an engineer.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

- A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
 1. Regulatory Requirements: Provide stairs and railings that comply with most stringent requirements of local, state, and federal regulations; where requirements of Contract Documents exceed those of regulations, comply with Contract Documents.
 2. Handrails: Comply with applicable accessibility requirements of ADA Standards.
 - a. Refer to drawings for details
 3. Dimensions: As indicated on drawings.
 4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
 5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
 6. Separate dissimilar metals using paint or permanent tape.
- B. Metal Jointing and Finish Quality Levels:
 1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
 - a. Welded Joints: Continuously welded and ground smooth and flush.
 - b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
 - c. Exposed Edges and Corners: Eased to small uniform radius.
 - d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.
 2. Commercial: Exposed joints as inconspicuous as possible, whether welded or mechanical; underside of stair not covered by soffit IS considered exposed to view.
 - a. Welded Joints: Intermittently welded on back side, filled with body putty, and sanded smooth and flush.
 - b. Welds Exposed to View: Ground smooth and flush.
 - c. Mechanical Joints: Butted tight, flush, and hairline.
 - d. Bolts Exposed to View: Countersunk flat or oval head bolts; no exposed nuts.
 - e. Exposed Edges and Corners: Eased to small uniform radius.
 - f. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for satin or matte finish.
- C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.
- D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH CONCRETE TREADS

- A. Jointing and Finish Quality Level: Architectural, as defined above.

- B. Risers: Closed.
- C. Treads: Metal pan with field-installed concrete fill.
 - 1. Concrete Depth: as indicated on drawings
 - 2. Tread Pan Material: Steel sheet.
 - 3. Tread Pan Thickness: Refer to Structural details
 - 4. Concrete Reinforcement: Refer to Structural drawings
 - 5. Concrete Finish: as indicated on drawings.
- D. Risers: Same material and thickness as tread pans.
 - 1. Nosing Depth: Not more than 1-1/2 inch overhang.
 - 2. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch wide.
- E. Stringers: as indicated on structural drawings.
 - 1. Stringer Depth: As indicated on drawings.
 - 2. End Closure: Sheet steel of same thickness as risers welded across ends.
- F. Railings: Refer to drawings for type and configuration.
- G. Finish: Shop- or factory-prime painted.
- H. Under Side of Stair: Exposed to view, to be finished same as specified for other exposed to view surfaces.

2.03 PREFABRICATED STAIRS

- A. Alternating Tread Stairs: Welded metal unit; factory fabricated to the greatest degree possible.
 - 1. Design Requirements:
 - a. Stair Load Capacity: Support the following without exceeding the allowable working stress of the material.
 - 1) Single Point Load: 1000 pounds.
 - 2) Distributed Load: 100 pounds per square foot.
 - b. Guardrail and Handrail Capacity: Support the following without exceeding the allowable working stress of the material.
 - 1) Single Point Load: 200 pounds.
 - 2) Distributed Load: 50 pounds per linear foot.
 - c. Support the following without exceeding the allowable working stress of the material.
 - 1) Single Point Load: 1000 pounds.
 - 2) Distributed Load: 100 pounds per square foot.
 - 2. Materials: Aluminum; ASTM B221 ASTM B221M 6063 alloy, T52 temper.
 - a. Stair Angle: ____ degrees,
 - b. Components: Manufacturer's standard handrails, guardrails, non-skid treads and stringers.
 - c. Accessories: Manufacturer's standard foot divider with rubber bumper strip.
 - 3. Manufacturers:
 - a. Lapeyre Stair, Inc; Alternating Tread Stair: www.lapeyrestair.com/#sle.
 - b. Precision Ladders, LLC; Aluminum Alternating Tread Stairs: www.precisionladders.com/#sle.
 - c. Or Equal.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.04 HANDRAILS AND GUARDS

- A. Wall-Mounted Rails: Round pipe or tube rails unless otherwise indicated.
 - 1. Outside Diameter: 1-1/4 inch, minimum, to 1-1/2 inches, maximum.
- B. Guards:
 - 1. Top Rails: Round pipe or tube rails unless otherwise indicated.
 - a. Outside Diameter: as indicated on drawings
 - 2. Infill at Pipe Railings: Pipe or tube rails sloped parallel to stair.
 - a. Outside Diameter: 1 inch.

- b. Material: Steel pipe or tube, round.
 - c. Vertical Spacing: Maximum 4 inches on center.
 - d. Jointing: Welded and ground smooth and flush.
- 3. End and Intermediate Posts: Same material and size as top rails.
 - a. Horizontal Spacing: As indicated on drawings.
 - b. Mounting: Welded to top surface of stringer.

2.05 MATERIALS

- A. Steel Sections: ASTM A36/A36M.
- B. Steel Tubing: ASTM A500/A500M or ASTM A501/A501M structural tubing, round and shapes as indicated.
- C. Pipe: ASTM A53/A53M Grade B Schedule 40, black finish.
- D. Ungalvanized Steel Sheet: Hot- or cold-rolled, except use cold-rolled where finished work will be exposed to view.
 - 1. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Designation CS (commercial steel).
 - 2. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Designation CS (commercial steel).
- E. Concrete Fill: See Section 033000.
- F. Concrete Reinforcement: Mesh type as detailed, galvanized.

2.06 SHOP FINISHING

- A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- B. Do not prime surfaces in direct contact with concrete or where field welding is required.
- C. Prime Painting: Use specified shop- and touch-up primer.
 - 1. Preparation of Steel: In accordance with SSPC-SP 2 Hand Tool Cleaning.
 - 2. Number of Coats: One.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. When field welding is required, clean and strip primed steel items to bare metal.
- B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.03 INSTALLATION

- A. Install components plumb and level, accurately fitted, free from distortion or defects.
- B. Provide anchors, plates, angles, hangers, and struts required for connecting stairs to structure.
- C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- D. Provide welded field joints where specifically indicated on drawings. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.
- F. Obtain approval prior to site cutting or creating adjustments not scheduled.
- G. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION 055100

SECTION 055213 METAL RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Wall mounted handrails.
- B. Stair railings and guardrails.
- C. Free-standing railings at steps.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Placement of anchors in concrete.
- B. Section 042000 - Unit Masonry: Placement of anchors in masonry.
- C. Section 092116 - Gypsum Board Assemblies: Placement of backing plates in stud wall construction.
- D. Section 099000 - Painting: Field paint finish of railings

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings; 2020.
- C. ASTM E935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2021.
- D. ASTM E985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings; 2024.
- E. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- F. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2026.
- G. AWS C3.4M/C3.4 - Specification for Torch Brazing; 2026.
- H. AWS C3.5M/C3.5 - Specification for Induction Brazing; 2016, with Amendment (2017).
- I. AWS C3.9M/C3.9 - Specification for Resistance Brazing; 2020.
- J. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Amendment (2026).
- K. AWS D1.6/D1.6M - Structural Welding Code - Stainless Steel; 2017, with Amendment (2021).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.
 - 1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Welders' Qualification Statement: Welders' certificates in accordance with AWS B2.1/B2.1M and dated within the previous 12 months.
- D. Fabricator's Qualification Statement.

1.05 QUALITY ASSURANCE

- A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in Arkansas, or personnel under direct supervision of such an engineer.
- B. Welder Qualifications: Welding processes and welding operators qualified within previous 12 months.
- C. Fabricator Qualifications:

1. A company specializing in manufacturing products specified in this section, with not less than five years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Rail Infill:
 1. McNICHOLS® Perforated Metal
 - a. Refer to **MP-02** on **Drawing A702 - Interior Material Legend** for product details
 - b. Accessories:
 - 1) U-Edging around full perimeter of panel

2.02 RAILINGS - GENERAL REQUIREMENTS

- A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of applicable local code.
- B. Comply with ASTM E985.
- C. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- D. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935
- E. Allow for expansion and contraction of members and building movement without damage to connections or members.
- F. Dimensions: See drawings for configurations and heights.
- G. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
 1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
 2. For anchorage to masonry, provide brackets to be embedded in masonry, for bolting anchors.
 3. For anchorage to stud walls, provide backing plates, for bolting anchors.
 4. Posts: Provide adjustable flanged brackets.
- H. Provide mechanical and welding fittings where indicated to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.
- I. Welded and Brazed Joints: Make visible joints butt tight, flush, and hairline; use methods that avoid discoloration and damage of finish; grind smooth, polish, and restore to required finish.
 1. Ease exposed edges to a small uniform radius.
 2. Welded Joints:
 - a. Carbon Steel: Perform welding in accordance with AWS D1.1/D1.1M.
 - b. Stainless Steel: Perform welding in accordance with AWS D1.6/D1.6M.
 3. Brass/Bronze Brazed Joints:
 - a. Perform torch brazing in accordance with AWS C3.4M/C3.4.
 - b. Perform induction brazing in accordance with AWS C3.5M/C 3.5.
 - c. Perform resistance brazing in accordance with AWS C3.9M/C3.9.

2.03 FABRICATION

- A. Accurately form components to suit specific project conditions and for proper connection to building structure.
- B. Fit and shop assemble components in largest practical sizes for delivery to site.

- C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
- D. Welded Joints:
 - 1. Exterior Components: Continuously seal joined pieces by continuous welds. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
 - 2. Interior Components: Continuously seal joined pieces by continuous welds.
 - 3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
- E. Weld connections that cannot be shop welded due to size limitations.
 - 1. Weld in accordance with AWS D1.1/D1.1M.
 - 2. Match shop welding and bolting.
 - 3. Clean welds, bolted connections, and abraded areas.
 - 4. Touch up shop primer and factory-applied finishes.
 - 5. Repair galvanizing with galvanizing repair paint per ASTM A780/A780M.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

- A. Clean and strip primed steel items to bare metal where site welding is required.
- B. Supply items required to be cast into concrete, embedded in masonry, or placed in partitions with setting templates, for installation as work of other sections.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
- C. Install railings in compliance with ADA Standards for accessible design at applicable locations.
- D. Anchor railings securely to structure.
- E. Field weld anchors as indicated on drawings. Touch-up welds with primer. Grind welds smooth.
- F. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION 055213

SECTION 061000 ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Rough opening framing for doors, windows, and roof openings.
- B. Roof-mounted curbs.
- C. Roofing nailers.
- D. Preservative treated wood materials.
- E. Fire retardant treated wood materials.
- F. Communications and electrical room mounting boards.
- G. Concealed wood blocking, nailers, and supports.
- H. Miscellaneous wood nailers, furring, and grounds.
- I. Wall sheathing with factory applied water-resistive and air barrier sheet.

1.02 REFERENCE STANDARDS

- A. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- C. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials; 2021a.
- D. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2018.
- E. AWPA U1 - Use Category System: User Specification for Treated Wood; 2022.
- F. PS 1 - Structural Plywood; 2023.
- G. PS 20 - American Softwood Lumber Standard; 2025.
- H. SPIB (GR) - Standard Grading Rules; 2021.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide technical data on the following products:
 - 1. Metal framing anchors
 - 2. Construction Adhesives
 - 3. Wall Sheathing

1.04 DELIVERY, STORAGE, AND HANDLING

- A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.
- B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, and installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
 - 1. Species: Southern Pine or Douglas Fir, unless otherwise indicated.
 - 2. If no species is specified, provide species graded by the agency specified; if no grading agency is specified, provide lumber graded by grading agency meeting the specified requirements.

3. Grading Agency: Grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee at www.alsc.org, and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.
- B. Lumber salvaged from deconstruction or demolition of existing buildings or structures is permitted in lieu of sustainably harvested lumber provided it is clean, denailed, and free of paint and finish materials, and other contamination; identify source.

2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS

- A. Grading Agency: Southern Pine Inspection Bureau, Inc; SPIB (GR).
- B. Sizes: Nominal sizes as indicated on drawings, S4S.
- C. Moisture Content: S-dry or MC19.
- D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
 1. Lumber: S4S, No. 2 or Standard Grade.
 2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

- A. Wall Sheathing: Glass mat faced gypsum with integral water-resistive and air barrier, ASTM C1177/C1177M, 5/8 inch thick.
 1. Edges: Square.
 2. Water Vapor Permeance: 1 perm, minimum, when tested in accordance with ASTM E96/E96M.
 3. Air Permeance, Sheathing: 0.001 cfm/sq ft, maximum, when tested in accordance with ASTM E2178.
 4. Air Permeance, Assembly: 0.04 cfm/sq ft, maximum, when tested in accordance with ASTM E2357.
 5. Fluid-Applied Flashing: Approved by sheathing manufacturer.
 6. Products:
 - a. Georgia-Pacific LLC; DensElement Barrier System: www.DensElement.com/#sle.
 - b. Tremco Commercial Sealants & Waterproofing; Securock ExoAir 430 Panel: www.tremcosealants.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- B. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

2.04 ACCESSORIES

- A. Fasteners and Anchors:
 1. Metal and Finish: Hot-dipped galvanized steel complying with ASTM A153/A153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.

2.05 FACTORY WOOD TREATMENT

- A. Treated Lumber and Plywood: Comply with requirements of AWWA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
 1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
 2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWWA standards.
- B. Fire Retardant Treatment:
 1. Interior Type A: AWWA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread index of 25 when tested in accordance with

ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.

- a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
- b. Treat rough carpentry items as indicated .
- c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:

1. Preservative Pressure Treatment of Lumber Above Grade: AWWA U1, Use Category UC3B, Commodity Specification A using waterborne preservative.
 - a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
 - b. Treat lumber exposed to weather.
 - c. Treat lumber in contact with roofing, flashing, or waterproofing.
 - d. Treat lumber in contact with masonry or concrete.

PART 3 EXECUTION

3.01 PREPARATION

- A. Coordinate installation of rough carpentry members specified in other sections.

3.02 INSTALLATION - GENERAL

- A. Select material sizes to minimize waste.
- B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
- C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.03 BLOCKING, NAILERS, AND SUPPORTS

- A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
- B. In framed assemblies that have concealed spaces, provide solid wood fireblocking as required by applicable local code, to close concealed draft openings between floors and between top story and roof/attic space; other material acceptable to authorities having jurisdiction may be used in lieu of solid wood blocking.
- C. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
- D. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
- E. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
- F. Provide the following specific nonstructural framing and blocking:
1. Cabinets and shelf supports.
 2. Wall brackets.
 3. Handrails.
 4. Grab bars.
 5. Towel and bath accessories.
 6. Wall-mounted door stops.
 7. Chalkboards and marker boards.
 8. Wall paneling and trim.
 9. Joints of rigid wall coverings that occur between studs.

3.04 ROOF-RELATED CARPENTRY

- A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.
- B. Provide wood curb at each roof opening except where specifically indicated otherwise; form corners by alternating lapping side members.

3.05 INSTALLATION OF CONSTRUCTION PANELS

- A. Wall Sheathing: Secure with long dimension perpendicular to wall studs, with ends over firm bearing and staggered, using nails, screws, or staples.
- B. Communications and Electrical Room Mounting Boards: Secure with screws to studs with edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and into studs in field of board.
 - 1. At fire-rated walls, install board over wall board indicated as part of the fire-rated assembly.
 - 2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board parallel to studs.
 - 3. Install adjacent boards without gaps.
 - 4. Size: 48 by 96 inches, installed horizontally at ceiling height.

3.06 CLEANING

- A. Waste Disposal: See Section 017419 - Construction Waste Management and Disposal.
 - 1. Comply with applicable regulations.
 - 2. Do not burn scrap on project site.
 - 3. Do not burn scraps that have been pressure treated.
 - 4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.
- B. Do not leave wood, shavings, sawdust, etc. on the ground or buried in fill.
- C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION 061000

**SECTION 062000
FINISH CARPENTRY**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Finish carpentry items.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 064100 - Architectural Wood Casework: Shop fabricated custom cabinet work.
- C. Section 081416 - Flush Wood Doors.
- D. Section 099000 - Painting

1.03 REFERENCE STANDARDS

- A. ANSI A135.4 - Basic Hardboard; 2012 (Reaffirmed 2020).
- B. ANSI A208.1 - American National Standard for Particleboard; 2022.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- D. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- E. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- F. BHMA A156.9 - Cabinet Hardware; 2020.
- G. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.
- B. Sequence installation to ensure utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide manufacturer's product data, storage and handling instructions for factory-fabricated units.
 - 2. Provide data on fire retardant treatment materials and application instructions.
 - 3. Provide instructions for attachment hardware and finish hardware.
- C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- D. Samples: Submit two samples of wood trim 24 inch long.
- E. Manufacturer's Instructions: Provide manufacturer's installation instructions for factory-fabricated units.

1.06 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Single Source Responsibility: Provide and install this work from single fabricator.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated units to project site in original packages, containers or bundles bearing brand name and identification.
- B. Store finish carpentry items under cover, elevated above grade, and in a dry, well-ventilated area not exposed to heat or sunlight.
- C. Protect from moisture damage.
- D. Handle materials and products to prevent damage to edges, ends, or surfaces.

PART 2 PRODUCTS

2.01 FINISH CARPENTRY ITEMS

- A. Quality Standard: Premium Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Interior Woodwork Items:
 - 1. Moldings, Casings, and Miscellaneous Trim: Poplar; prepare for paint or transparent finish as noted on drawings.

2.02 SHEET MATERIALS

- A. Hardwood Plywood: Face species as indicated, plain sawn, veneer core, glue type as recommended for application.
- B. Particleboard: ANSI A208.1 Composed of wood chips, sawdust, or flakes of medium density, made with waterproof resin binders; of grade to suit application; sanded faces.
- C. Hardboard: ANSI A135.4 Pressed wood fiber with resin binder, Class 1 - Tempered, 1/4 inch thick, smooth one side (S1S).

2.03 PLASTIC LAMINATE MATERIALS

- A. Plastic Laminate: NEMA LD 3; color as selected by Architect; finish as selected.
 - 1. Products: Refer to Drawing **A7 INTERIOR - FINISH LEGEND**
 - a. Substitutions: See Section 016000 - Product Requirements.
- B. Laminate Backing Sheet: NEMA LD 3, BKL; undecorated plastic laminate.
- C. Laminate Adhesive: Type recommended by laminate manufacturer to suit application; not containing formaldehyde or other volatile organic compounds.

2.04 FASTENINGS

- A. Adhesive for Purposes Other Than Laminate Installation: Suitable for the purpose; not containing formaldehyde or other volatile organic compounds.
- B. Adhesive for factory-fabricated units: Manufacturer's recommended adhesive for application.
- C. Concealed Joint Fasteners: Threaded steel.

2.05 ACCESSORIES

- A. Adhesive: Type recommended by fabricator to suit application.
- B. Lumber for Shimming and Blocking: Softwood lumber of indicated species.
- C. Wood Filler: Solvent base, tinted to match surface finish color.

2.06 HARDWARE: REFER TO A701 INTERIOR - FINISH LEGEND

- A. Hardware: Comply with BHMA A156.9.
- B. Countertop Support Brackets: Fixed, L-shaped, corner reinforced, face-of-stud mounting.
 - 1. Material: Steel.
 - a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - b. Color: Black.
 - c. Height: 5 inches.
 - d. Support Length: 8 inches.

2. Products:
 - a. A&M Hardware, Inc; Standard Brackets: www.aandmhardware.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- C. Countertop Support Brackets: Fixed, L-shaped, face-of-stud mounting.
 1. Material: Steel; T-shape cross-section.
 - a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - b. Color: Black.
 - c. Height: 9 inches.
 - d. Support Length: 9 inches.
 - e. Width: 1 inch.
 2. Products:
 - a. A&M Hardware, Inc; Hybrid Brackets: www.aandmhardware.com/#sle.
 - b. A&M Hardware, Inc; Heavy-Duty Hybrid Brackets: www.aandmhardware.com/#sle.
 - c. Substitutions: See Section 016000 - Product Requirements.
- D. Vanity Brackets: Fixed, ADA-Compliant, face-of-stud mounting.
 1. Material: Steel; formed compound shapes.
 - a. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 - b. Color: Black.
 2. Products:
 - a. A&M Hardware, Inc; ADA Vanity Brackets: www.aandmhardware.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- E. Countertop Brackets: Fixed, L-shaped, top of knee wall mounting.
 1. Material: Steel plates.
 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 3. Color: Black.
 4. Plate Thickness and Width: 3/8 inch by 2-1/2 inches.
 5. Products:
 - a. Centerline Brackets; Front Mounting Bracket: www.countertopbracket.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- F. Vanity Brackets: Fixed, cantilevered support leg, face-of-stud mounting.
 1. Materials: Steel L-shapes.
 2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
 3. Color: Black.
 4. Angle Depth: 2 inches.
 5. Width: 28 inches.
 6. Support Length: 18 inches.
 7. Products:
 - a. A&M Hardware, Inc; Floating Vanity Brackets: www.aandmhardware.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.
- G. Countertop Brackets: Concealed vertical leg, side-of-stud mounting.
 1. Material: Steel plates.
 - a. Finish: Manufacturer's standard, factory-applied powder coat.
 - b. Color: Black.
 - c. Vertical Leg: 8 inches.
 - d. Support Plate Length: 7 inches.
 - e. Plate Thickness: 1/2 inch.
 - f. Plate Width: 2-1/2 inches.
 2. Products:
 - a. Centerline Brackets; Floating Wall Mount: www.countertopbracket.com/#sle.
 - b. Substitutions: See Section 016000 - Product Requirements.

2.07 WOOD TREATMENT

- A. Factory-Treated Lumber: Comply with requirements of AWP A U1 - Use Category System for pressure impregnated wood treatments determined by use categories, expected service conditions, and specific applications.
- B. Fire Retardant Treatment (FR-S Type): Chemically treated and pressure impregnated; capable of providing flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
- C. Provide identification on fire retardant treated material.
- D. Redry wood after pressure treatment to maximum 14 percent moisture content.

2.08 SITE FINISHING MATERIALS

- A. Stain, Shellac, Varnish, and Finishing Materials: Comply with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

2.09 FABRICATION

- A. Shop assemble work for delivery to site, permitting passage through building openings.
- B. Cap exposed plastic laminate finish edges with material of same finish and pattern.
- C. When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide trim for scribing and site cutting.
- D. Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
- E. Apply laminate backing sheet to reverse face of plastic laminate finished surfaces.

2.10 SHOP FINISHING

- A. Sand work smooth and set exposed nails and screws.
- B. Apply wood filler in exposed nail and screw indentations.
- C. On items to receive transparent finishes, use wood filler that matches surrounding surfaces and is of type recommended for the applicable finish.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.
- C. See Section 061000 for installation of recessed wood blocking.

3.02 INSTALLATION

- A. Install custom fabrications in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
- B. Set and secure materials and components in place, plumb and level.
- C. Carefully scribe work abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim to conceal larger gaps.
- D. Install prefinished paneling with full bed contact adhesive applied to substrate.

3.03 TOLERANCES

- A. Maximum Variation from True Position: 1/16 inch.
- B. Maximum Offset from True Alignment with Abutting Materials: 1/32 inch.

END OF SECTION 062000

SECTION 064100
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Specially fabricated cabinet units.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Support framing, grounds, and concealed blocking.
- B. Section 123600 - Countertops.

1.03 REFERENCE STANDARDS

- A. ANSI A208.2 - Medium Density Fiberboard (MDF) for Interior Applications; 2022.
- B. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- C. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- D. BHMA A156.9 - Cabinet Hardware; 2020.
- E. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
 - 1. Scale of Drawings: 1-1/2 inch to 1 foot, minimum.
 - 2. Provide information as required by AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS).
- C. Product Data: Provide data for hardware accessories.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.
 - 1. Company with at least one project in the past 5 years with value of woodwork within 20 percent of cost of woodwork for this Project.
 - 2. Single Source Responsibility: Provide and install this work from single fabricator.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from moisture damage.

1.07 FIELD CONDITIONS

- A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 CABINETS

- A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
- B. Plastic Laminate Faced Cabinets: Custom grade.
- C. Exposed Exterior, Exposed Interior, and partially exposed Surfaces to be High-Pressure decorative Laminate.
- D. Cabinet interiors to be white melamine.
- E. Cabinet style frameless flush overlay with square edges

2.02 WOOD-BASED COMPONENTS

- A. Wood fabricated from old growth timber is not permitted.

2.03 LAMINATE MATERIALS

- A. Manufacturers:
 - 1. See drawings for specifications
 - 2. Substitutions: See Section 016000 - Product Requirements.
- B. Provide specific types as indicated.

2.04 COUNTERTOPS

- A. Countertops: See Section 123600.

2.05 ACCESSORIES

- A. Plastic Edge Banding: Extruded PVC, convex shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
 - 1. Color: As indicated on drawings.
 - 2. Use at all exposed plywood edges.
 - 3. Use at all exposed shelf edges.
- B. Fasteners: Size and type to suit application.
- C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.
- D. Concealed Joint Fasteners: Threaded steel.
- E. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.06 FABRICATION

- A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
- B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
- C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
- D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet from sink cut-outs.
 - 1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
 - 2. Cap exposed plastic laminate finish edges with material of same finish and pattern.
- E. Matching Wood Grain: Comply with requirements of quality standard for specified Grade and as follows:
 - 1. Provide sequence matching across each elevation.
 - 2. Carry figure of cabinet fronts to toe kicks.
- F. Mechanically fasten back splash to countertops as recommended by laminate manufacturer at 16 inches on center.
- G. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify adequacy of backing and support framing.
- B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

- A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

- B. Use concealed joint fasteners to align and secure adjoining cabinet units.

3.03 ADJUSTING

- A. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

- A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION 064100

SECTION 072100 THERMAL INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Board insulation at exterior wall behind exterior wall finish.
- B. Batt insulation in exterior wall, ceiling, and roof construction.
- C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.

1.02 RELATED REQUIREMENTS

- A. Section 075400 - Thermoplastic Membrane Roofing: Installation requirements for board insulation over low slope roof deck.

1.03 DEFINITIONS

- A. Mineral Fiber Material Composition: Insulation referred to as mineral fiber block, board, and blanket insulation is composed of fibers from mineral based substances such as rock, slag, or glass and processed from the molten state into fibrous form.
 - 1. Based on type of insulation substance, the material will be referred to as a mineral fiber when having a rock or slag base, and glass fiber with a glass or silica sand base, also considered a mineral.
 - 2. Insulation blankets are flexible units consisting of felted, bonded, or unbonded fibers formed into rolls or flat cut pieces referred to as batts; rolls are simply longer versions of batts.
 - 3. For additional information about mineral fiber and the various classification types, refer to the following reference standards; ASTM C553, ASTM C612, ASTM C665, and ASTM C726.

1.04 REFERENCE STANDARDS

- A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- B. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2023.
- C. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation; 2014 (Reapproved 2019).
- D. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing; 2023.
- E. ASTM C726 - Standard Specification for Mineral Wool Roof Insulation Board; 2024.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- G. ASTM E136 - Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750 °C; 2022.
- H. ASTM E2357 - Standard Test Method for Determining Air Leakage Rate of Air Barrier Assemblies; 2018.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
- C. Shop Drawings: Submit drawings that indicate location of joint or termination detail conditions.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Insulation Over exterior Metal Stud Framed Walls with gyp sheathing, Continuous: Extruded polystyrene (XPS) board.
- B. Insulation in Metal Framed Walls: Batt insulation with no vapor retarder.

2.02 FOAM BOARD INSULATION MATERIALS

- A. Extruded Polystyrene (XPS) Board Insulation: Comply with ASTM C578 with either natural skin or cut cell surfaces.
 - 1. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
 - 2. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
 - 3. Type and Thermal Resistance, R-value: Type V, 5.0, (0.88), minimum, per 1 inch thickness at 75 degrees F mean temperature.
 - 4. Products:
 - a. DuPont de Nemours, Inc: building.dupont.com/#sle.
 - b. Kingspan Insulation LLC: www.kingspan.com/#sle.
 - c. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.03 MINERAL FIBER BLANKET INSULATION MATERIALS

- A. Flexible Glass Fiber Blanket Thermal Insulation: Preformed insulation, complying with ASTM C665; friction fit.
 - 1. Combustibility: Non-combustible, when tested in accordance with ASTM E136, except for facing, if any.
 - 2. Formaldehyde Content: Zero.
 - 3. Thermal Resistance: R-value of 13.

2.04 ACCESSORIES

- A. Tape: Reinforced polyethylene film with acrylic pressure sensitive adhesive.
 - 1. Application: Sealing of interior circular penetrations, such as pipes or cables.
 - 2. Width: As required for application.
- B. Self-Adhered Transition Flashing: Multipurpose, self-adhered flashing with modified butyl adhesive, polyester fiber top sheet, and polypropylene interlayer.
 - 1. Application: Primerless adhesion for use as through-wall flashings and wall transitions to roof and below-grade systems.
 - 2. Thickness: 45 mil, 0.045 inch, nominal.
 - 3. Size: 6 inches wide, in rolls 75 feet long.
- C. Flashing Tape: Special reinforced film with high performance adhesive.
 - 1. Application: Window and door opening flashing tape.
 - 2. Width: As required for application.
- D. Sill Plate Sealer: Closed-cell foam tape with rubberized adhesive membrane; bridges gap between foundation structure and sill plate or skirt board.
 - 1. Width: 5-1/2 inches.
 - 2. Ultraviolet (UV) and Weathering Resistance: Approved in writing by manufacturer for up to 30 days of weather exposure.
- E. Tape joints of rigid insulation in accordance with roofing and insulation manufacturers' instructions.
- F. Support for Cladding and Continuous Insulation: Continuous thermal Z-girts.
 - 1. Fiberglass reinforced plastic (FRP) girts that provide cladding attachment support for exterior wall cladding and brick veneer.
 - 2. Depth: As required for thickness of insulation.
 - 3. Fasteners: As recommended by clip manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.
- B. Verify substrate surfaces are flat, free of honeycomb, fins, irregularities, or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT EXTERIOR WALLS

- A. Install rigid insulation directly to steel studs or exterior grade sheathing at 16 inches on center with manufacturer recommended mechanical fasteners, and tape joints with manufacturer's minimum 4 inches wide sealant tape; comply with ASTM E2357.
- B. Install boards horizontally on walls.
- C. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION USING CLADDING AND CONTINUOUS INSULATION SUPPORTS

- A. Install supports in accordance with manufacturer's installation instructions.
- B. Install supports in compliance with system orientation, sizes, and locations as indicated on drawings and in accordance with approved shop drawings.
- C. Install supports to fill in exterior wall spaces without gaps or voids in insulation.
- D. Trim insulation neatly to fit spaces and provide a continuous thermal layer.

3.04 BATT INSTALLATION

- A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
- B. Install in exterior wall spaces without gaps or voids. Do not compress insulation.
- C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
- D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.

3.05 PROTECTION

- A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION 072100

**SECTION 074213
METAL WALL PANELS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Exterior wall panels.
- B. Related flashings.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Wall panel substrate.
- B. Section 061000 - Rough Carpentry: Wall panel substrate.
- C. Section 072100 - Thermal Insulation.
- D. Section 076200 - Sheet Metal Flashing and Trim: Transitions between wall panel substrate and wall panels.
- E. Section 079200 - Joint Sealants: Sealing joints between metal wall panel system and adjacent construction.

1.03 REFERENCE STANDARDS

- A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum (Combined Document); 2015.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data - Wall System: Manufacturer's data sheets on each product used, including:
 - 1. Physical characteristics of components shown on shop drawings.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation instructions and recommendations.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and anchorage methods.
- D. Samples: Submit two samples of wall panel, 12 by 12 inches in size illustrating finish color, sheen, and texture.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
- B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
- C. Prevent contact with materials that may cause discoloration or staining of products.

1.07 FIELD CONDITIONS

- A. Do not install wall panels when air temperature or relative humidity is outside manufacturer's limits.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.

- B. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

1.09 MANUFACTURER

- A. Metal Wall Panels - Concealed Fasteners:
 - 1. **MP-01:** Petersen Aluminum Corporation; Box Rib 1: www.pac-clad.com/#sle.
 - 2. **MP-03:** Petersen Aluminum Corporation; Flush Wall Panels: www.pac-clad.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.
 - 4. Provide exterior wall panels and subgirt framing assembly.
 - 5. Provide components which will support panel dead loads and withstand live loads caused by positive and negative wind pressure acting normally to plane of wall.
 - 6. Design Pressure: In accordance with applicable codes.
 - 7. Movement: Accommodate movement within system without damage to components or deterioration of seals; between system and perimeter components when subject to seasonal temperature cycling; when subject to dynamic loading and release of loads; and under deflection of structural support framing.
 - 8. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
 - 9. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
 - 10. Provide continuity of weather barrier seal at building enclosure elements in accordance with requirements; see Section 072500.
- B. Exterior Wall Panels: Refer to Drawing **A2.20 EXTERIOR - FINISH LEGEND**
 - 1. Side Seams: Double-interlocked, tight-fitting, sealed with continuous gaskets.
 - 2. Color: As selected by Architect from manufacturer's full line.

1.10 FINISHES

- A. Exposed Surface Finish: Panel manufacturer's standard polyvinylidene fluoride (PVDF) coating, top coat over epoxy primer.
- B. Panel Backside Finish: Panel manufacturer's standard siliconized polyester wash coat.

1.11 ACCESSORIES

- A. Subgirts: Z-girts as indicated on drawings.
- B. Flashing: See Section 076200.
- C. Gaskets: Manufacturer's standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.
- D. Concealed Sealant: Noncuring butyl or tape sealant; see Section 07 9200.
- E. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane; see Section 07 9200.
- F. Fasteners: Manufacturer's standard type to suit application; with soft neoprene washers, steel, hot-dip galvanized. Fastener cap same color as exterior panel.
- G. Field Touch-Up Paint: As recommended by panel manufacturer, only in locations approved by architect.

PART 3 EXECUTION

2.01 EXAMINATION

- A. Verify that building framing members are ready to receive panels.

2.02 PREPARATION

- A. Install subgirts perpendicular to panel length, securely fastened to substrates and shimmed and leveled to uniform plane, and spaced at intervals indicated.

- B. Protection of In-Place Conditions: Protect surrounding areas and adjacent surfaces from damage during execution of this work.

2.03 INSTALLATION

- A. Install panels on walls in accordance with manufacturer's instructions.
- B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint; allow to dry prior to wall panel installation.
- C. Fasten panels to structural supports; align, level, and plumb.
- D. Locate joints over supports.
- E. Lap panel ends 2 inches, minimum.
- F. Provide expansion and control joints where indicated.
- G. Use concealed fasteners unless otherwise indicated by Architect.
- H. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

2.04 TOLERANCES

- A. Offset from True Alignment between Adjacent Members Abutting or In Line: 1/16 inch, maximum.
- B. Variation from Plane or Location as Indicated on Drawings: 1/4 inch, maximum.

2.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove site cuttings from finish surfaces.
- C. Remove protective material from wall panel surfaces.
- D. Upon completion of installation, thoroughly clean prefinished aluminum surfaces in accordance with AAMA 609 & 610.

2.06 PROTECTION

- A. Protect metal wall panels until completion of project.
- B. Touch up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

SECTION 074213.23
METAL COMPOSITE MATERIAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal composite material wall panels.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Panel support framing.
- B. Section 076200 - Sheet Metal Flashing and Trim: Metal flashing components integrated with this wall system.
- C. Section 079200 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.

1.03 REFERENCE STANDARDS

- A. ASTM D1781 - Standard Test Method for Climbing Drum Peel for Adhesives; 1998 (Reapproved 2021).
- B. ASTM D1929 - Standard Test Method for Determining Ignition Temperature of Plastics; 2023.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- D. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data - MCM Sheets: Manufacturer's data sheets on each product to be used, including thickness, physical characteristics, and finish, and:
 - 1. Finish manufacturer's data sheet showing physical and performance characteristics.
 - 2. Storage and handling requirements and recommendations.
 - 3. Fabrication instructions and recommendations.
 - 4. Specimen warranty for finish, as specified herein.
- C. Product Data - Wall System: Manufacturer's data sheets on each product to be used, including:
 - 1. Physical characteristics of components shown on shop drawings.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation instructions and recommendations.
 - 4. Specimen warranty for wall system, as specified herein.
- D. Shop Drawings: Show layout and elevations, dimensions and thickness of panels, connections, details and location of joints, sealants and gaskets, method of anchorage, support clips, exposed fasteners, number of anchors, supports, reinforcement, trim, flashings, and accessories.
 - 1. Indicate panel numbering system.
 - 2. Differentiate between shop and field fabrication.
 - 3. Indicate substrates and adjacent work with which the wall system must be coordinated.
 - 4. Include large-scale details of anchorages and connecting elements.
 - 5. Include large-scale details or schematic, exploded or isometric diagrams to fully explain flashing at a scale of not less than 1-1/2 inches per 12 inches.
- E. Selection Samples: For each finish product specified, submit at least two sample color chips representing manufacturer's custom range of available colors and patterns.
- F. Verification Samples: For each finish product specified, submit at least two samples, minimum size 12 inch square, and representing actual product in color and texture.

- G. Maintenance Data: Care of finishes and warranty requirements.

1.05 QUALITY ASSURANCE

- A. Field Measurements: Verify actual dimensions by field measurement before fabrication; show recorded measurements on shop drawings.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products in manufacturer's original, unopened, undamaged containers with identification labels intact.
 - 1. Protect finishes by applying heavy-duty removable plastic film during production.
 - 2. Package for protection against transportation damage.
 - 3. Provide markings to identify components consistently with drawings.
 - 4. Exercise care in unloading, storing, and installing panels to prevent bending, warping, twisting, and surface damage.
- B. Store products protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
 - 1. Store in well-ventilated space out of direct sunlight.
 - 2. Protect from moisture and condensation with tarpaulins or other suitable weathertight covering installed to provide ventilation.
 - 3. Store at a slope to ensure positive drainage of accumulated water.
 - 4. Do not store in enclosed space where ambient temperature can exceed 120 degrees F.
 - 5. Avoid contact with other materials that might cause staining, denting, or other surface damage.

1.07 FIELD CONDITIONS

- A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Metal Composite Material (MCM) Sheet Manufacturers:
 - 1. ALUCOBOND by 3A Composites USA: www.alucobondusa.com/#sle.
 - 2. ALPOLIC Materials: www.alpolic-america.com/#sle.
 - 3. Arconic Architectural Products LLC: www.arconic.com/#sle.
 - 4. Carter Architectural Panels, Inc: www.elval-colour.com/#sle.
- B. Wall Panel System Manufacturers:
 - 1. ACM Panelworx Inc: www.acmpanelworx.com/#sle.
 - 2. Carter Architectural Panels, Inc: www.carterpanels.com/#sle.
 - 3. Centerline Systems: www.centerlinesystems.net/#sle.
 - 4. Petersen Aluminum Corporation: www.pac-clad.com/#sle.
 - 5. Or Approved Equal.
 - 6. Substitutions: See Section 016000 - Product Requirements.

2.02 METAL COMPOSITE MATERIAL WALL PANELS

- A. Performance Requirements:
 - 1. Design and size components to support assembly dead loads and withstand live loads caused by positive and negative wind pressure acting normally to plane of wall.
 - 2. Structural Performance:
 - a. Comply with ASTM E330/E330M, using test pressure 1.5 times design wind pressure, with 10-second maximum load duration.
 - 3. Movement:
 - a. Accommodate movement within system without damage to components or seal deterioration.

- b. Accommodate movement between system and perimeter components when subject to dynamic loading, release of loads, and support framing deflection.
 - c. Ensure free and noiseless movement from expansion and contraction under material temperature range of minus 20 to 180 degrees F, without buckling, fastener stress, joint opening, or other detrimental effects.
- 4. Drainage: Provide positive drainage to exterior for moisture entering system and condensation occurring within system.
- B. Panels: 1-inch deep pans formed of metal composite material sheet by routing back edges of sheet, removing corners, and folding edges.
 - 1. Reinforce corners with riveted aluminum angles.
 - 2. Provide concealed attachment to supporting structure by adhering attachment members to back of panel; attachment members may also function as stiffeners.
 - 3. Maintain maximum panel bow of 0.8 percent of panel dimension in width and length; provide stiffeners of sufficient size and strength to maintain panel flatness without showing local stresses or read-through on panel face.
 - 4. Secure members to back face of panels using structural silicone sealant approved by MCM sheet manufacturer.
 - 5. Fabricate panels under controlled shop conditions.
 - 6. Where final dimensions cannot be established by field measurement before commencement of manufacturing, make allowance for field adjustments without requiring field fabrication of panels.
 - 7. Fabricate as indicated on drawings and as recommended by MCM sheet manufacturer.
 - a. Make panel lines, breaks, curves, and angles sharp and true.
 - b. Keep plane surfaces free from warp or buckle.
 - c. Keep panel surfaces free of scratches or marks caused during fabrication.
 - 8. Provide joint details providing a watertight and structurally sound wall panel system that allows no uncontrolled water penetration on inside face of panel system.

2.03 MATERIALS

- A. Metal Composite Material (MCM) Sheet: Two sheets of aluminum sandwiching a core of extruded thermoplastic material; no foamed insulation material content.
 - 1. Overall Sheet Thickness: 0.118 inch, minimum.
 - 2. Bond and Peel Strength: No adhesive failure of the bond between the core and the skin nor cohesive failure of the core itself below 22.4 inch-pound/inch with no degradation in bond performance, when tested in accordance with ASTM D1781, simulating resistance to panel delamination, after 8 hours of submersion in boiling water and after 21 days of immersion in water at 70 degrees F.
 - 3. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
 - 4. Flammability: Self-ignition temperature of 650 degrees F or greater when tested in accordance with ASTM D1929.
- B. Metal Framing Members: Include sub-girts, zee-clips, base and sill angles and channels, hat-shaped and rigid channels, and furring channels required for complete installation.
 - 1. Provide material strength, dimensions, configuration as required to meet applied loads and in compliance with applicable building code.

2.04 FINISHES

- A. Color/Texture: As selected by Architect from manufacturer's custom range.

2.05 ACCESSORIES

- A. Flashing: Sheet aluminum; 0.040 inch thick, minimum; finish and color to match MCM sheet; see Section 076200 for additional requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine dimensions, tolerances, and interfaces with other work.
 - 1. Verify that weather barrier system is properly installed; see Section 072500 for requirements.
- B. Examine substrate on-site to determine that conditions are acceptable for product installation in accordance with manufacturer's written instructions.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- D. Notify Architect in writing of conditions detrimental to proper and timely completion of work, and do not proceed with erection until unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Protect adjacent work areas and finish surfaces from damage during installation.

3.03 INSTALLATION

- A. Do not install products that are defective, including warped, bowed, dented, and broken members, and members with damaged finishes.
- B. Install panels in accordance with manufacturer's instructions and approved shop drawings.
- C. Install wall system securely allowing for necessary thermal and structural movement; comply with wall system manufacturer's instructions for installation of concealed fasteners.
- D. Do not handle or tool products during erection in manner that damages finish, decreases strength, or results in visual imperfection or failure in performance. Return component parts that require alteration to shop for refabrication, if possible, or for replacement with new parts.
- E. Do not form panels in field unless required by wall system manufacturer and approved by the Architect; comply with MCM sheet manufacturer's instructions and recommendations for field forming.
- F. Separate dissimilar metals; use gasket fasteners, isolation shims, or isolation tape where needed to eliminate possibility of electrolytic action between metals.
- G. Install flashings as indicated on shop drawings. At flashing butt joints, provide a lap strap under flashing and seal lapped surfaces with a full bed of non-hardening sealant.
- H. Install square, plumb, straight, and true, accurately fitted, with tight joints and intersections maintaining the following installation tolerances:
 - 1. Variation From Plane or Location: 1/2 inch in 30 feet of length and up to 3/4 inch in 300 feet, maximum.
 - 2. Deviation of Vertical Member From True Line: 0.1 inch in 25 feet run, maximum.
 - 3. Deviation of Horizontal Member From True Line: 0.1 inch in 25 feet run, maximum.
 - 4. Offset From True Alignment Between Two Adjacent Members Abutting End To End, In Line: 0.03 inch, maximum.
- I. Replace damaged products.
 - 1. Exception: Field repairs of minor damage to finishes are permitted only when approved in writing by Architect, panel manufacturer, and fabricator.
 - 2. Field Repairs to Finishes: Using materials and methods sufficient that repairs are not discernible when viewed at distance of 10 feet under all typical light conditions experienced at the project.

3.04 CLEANING

- A. Ensure weep holes and drainage channels are unobstructed and free of dirt and sealants.
- B. Remove protective film after installation of joint sealers, after cleaning of adjacent materials, and immediately prior to completion of work.
- C. Remove temporary coverings and protection of adjacent work areas.

D. Clean installed products in accordance with manufacturer's instructions.

3.05 PROTECTION

A. Protect installed panel system from damage until Date of Substantial Completion.

END OF SECTION 074213.23

**SECTION 074646
FIBER-CEMENT SIDING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fiber-cement siding.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealing joints between siding and adjacent construction and fixtures.
- B. Section 099000 - Painting: Field painting.

1.03 REFERENCE STANDARDS

- A. ASTM C1186 - Standard Specification for Flat Fiber-Cement Sheets; 2022.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's data sheets on each product to be used, including:
 - 1. Manufacturer's requirements for related materials to be installed by others.
 - 2. Preparation instructions and recommendations.
 - 3. Storage and handling requirements and recommendations.
 - 4. Installation methods, including nail patterns.
- C. Shop Drawings: Indicate dimensions, layout, joints, construction details, support clips, and methods of anchorage.
- D. Manufacturer's qualification statement.
- E. Installer's qualification statement.
- F. Maintenance Instructions: Periodic inspection recommendations and maintenance procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store materials in manufacturer's unopened packaging, with labels intact, until ready for installation.
- B. Store materials under dry and waterproof cover, well ventilated, and elevated above grade on a flat surface.
- C. Protect materials from harmful environmental elements, construction dust, and other potentially detrimental conditions.

1.06 FIELD CONDITIONS

- A. Do not install panels when air temperature or relative humidity are outside manufacturer's limits.

PART 2 PRODUCTS

2.01 FIBER-CEMENT SIDING

- A. Panel Siding: Vertically oriented panels made of cement and cellulose fiber formed under high pressure with integral surface texture, complying with ASTM C1186, Type A, Grade II; with machined edges, for nail attachment.
 - 1. Texture: Smooth.
 - 2. Length (Height): 96 inches, nominal, or best height for application (refer to drawings).
 - 3. Width: 48 inches.
 - 4. Thickness: 5/16 inch, nominal.
 - 5. Finish: Factory applied primer.
 - 6. Warranty: 30 year limited; transferable.
 - 7. Products:
 - a. James Hardie Building Products, Inc: www.jameshardie.com/#sle.

- b. Or Approved Equal.
- c. Substitutions: See Section 016000 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine substrate, clean and repair as required to eliminate conditions that would be detrimental to proper installation.
- B. Do not begin until unacceptable conditions have been corrected.
- C. If substrate preparation is responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Protect surrounding areas and adjacent surfaces during execution of this work.
- B. Install Sheet Metal Flashing:
 - 1. Above door and window trim and casings.
 - 2. Above horizontal trim in field of siding.

3.03 INSTALLATION

- A. Support for Cladding and Continuous Insulation: Install in accordance with approved shop drawings and manufacturer's written instructions; securely fasten; shim and level to uniform plane.
 - 1. Spacing: As indicated on drawings.
- B. Install siding in accordance with manufacturer's instructions and recommendations.
 - 1. Read warranty and comply with terms necessary to maintain warranty coverage.
 - 2. Use trim details as indicated on drawings.
 - 3. Touch up field cut edges before installing.
 - 4. Pre-drill nail holes if necessary to prevent breakage.
- C. Over Steel Studs: Use hot-dipped galvanized self-tapping screws, with the points of at least three screws penetrating each stud the panel crosses and at panel ends.
- D. Allow space for thermal movement between both ends of siding panels that butt against trim; seal joint between panel and trim with specified sealant.
- E. Joints in Vertical Siding: Install Z-flashing in horizontal joints between successive courses of vertical siding.
- F. Do not install siding less than 6 inches from ground surface, or closer than 1 inch to roofs, patios, porches, and other surfaces where water may collect.
- G. After installation, seal joints; seal around penetrations, and seal all attachment penetrations to be flush with surface. Paint exposed cut edges.
- H. Finish Painting: See Section 099000.

3.04 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Clean faced panels in accordance with manufacturer's maintenance instructions, using cleaning materials and methods acceptable to manufacturer.

3.05 PROTECTION

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

END OF SECTION 074646

**SECTION 075400
THERMOPLASTIC MEMBRANE ROOFING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Adhered system with thermoplastic roofing membrane.
- B. Insulation, flat and tapered.
- C. Cover boards.
- D. Flashings.
- E. Other roofing-related items specified or indicated on the drawings or otherwise necessary to provide a complete weatherproof roofing system.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry:

1.03 REFERENCE STANDARDS

- A. ASTM C1177/C1177M - Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing; 2024.
- B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2025.
- C. ASTM D6878/D6878M - Standard Specification for Thermoplastic Polyolefin-Based Sheet Roofing; 2021.
- D. FM (AG) - FM Approval Guide; Current Edition.
- E. FM DS 1-28 - Wind Design; 2015, with Editorial Revision (2022).
- F. NRCA (RM) - The NRCA Roofing Manual; 2026.
- G. NRCA (WM) - The NRCA Waterproofing Manual; 2021.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene one week before starting work of this section.
 - 1. Review preparation and installation procedures and coordinating and scheduling required with related work.
 - 2. Require attendance of all parties directly influencing the quality of roofing work or affected by the performance of roofing work.
 - 3. Notify Architect well in advance of meeting.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, vapor retarder, surfacing, and fasteners. Comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with the roofing membrane.
- C. Shop Drawings: Submit drawings that indicate joint or termination detail conditions, conditions of interface with other materials, and setting plan for tapered insulation.
- D. Samples: Submit samples of each product to be used.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.
- G. Manufacturer's qualification statement.
- H. Installer's qualification statement.

- I. Specimen Warranty: Submit prior to starting work.
- J. Warranty Documentation:
 - 1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 2. Submit installer's written verification that installation complies with warranty conditions for waterproof membrane.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's original containers, dry and undamaged, with seals and labels intact, unless otherwise indicated.
- B. Store materials in weather protected environment, clear of ground and moisture.
- C. Ensure storage and staging of materials does not exceed static and dynamic load-bearing capacities of roof decking.
- D. Protect foam insulation from direct exposure to sunlight.

1.07 FIELD CONDITIONS

- A. Do not apply roofing membrane during unsuitable weather.
- B. Do not apply roofing membrane when ambient temperature is below 40 degrees F or above manufacturer recommended temperature.
- C. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- E. Schedule applications so that no partially completed sections of roof are left exposed at end of workday.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
 - 1. Warranty Term: 20 years.
 - 2. For repair and replacement include costs of both material and labor in warranty.
 - 3. Exceptions are not Permitted:
 - a. Damage due to roof traffic.
 - b. Damage due to wind speed greater than 56 miles per hour but less than 90 miles per hour.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Thermoplastic Polyolefin (TPO) Membrane Roofing Materials:
 - 1. Carlisle SynTec Systems; Sure-Weld TPO: www.carlisle-syntec.com/#sle.
 - 2. Elevate; UltraPly TPO Membrane: www.holcimelevate.com/#sle.
 - 3. GAF; EverGuard TPO 60 mil: www.gaf.com/#sle.
 - 4. Johns Manville; JM TPO - 60 mil: www.jm.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Insulation:
 - 1. Carlisle SynTec Systems; SecurShield Insulation: www.carlisle-syntec.com/#sle.
 - 2. DuPont de Nemours, Inc: building.dupont.com/#sle.
 - 3. GAF: www.gaf.com/#sle.
 - 4. Owens Corning Corporation: www.ocbuildingspec.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.02 MEMBRANE ROOFING AND ASSOCIATED MATERIALS

- A. Membrane Roofing Materials:
 - 1. TPO: Thermoplastic polyolefin (TPO) complying with ASTM D6878/D6878M, sheet contains reinforcing fabrics or scrim.
 - a. Thickness: 60 mil, 0.060 inch, minimum.
 - 2. Sheet Width:
 - a. Adhered Application: Limit width to 120 inches, maximum, when ambient temperatures are less than 40 degrees F for extended period of time during installation.
 - 3. Solar Reflectance: 0.75, minimum, initial, and 0.65, minimum, 3-year, certified by Cool Roof Rating Council.
 - 4. Thermal Emissivity: 0.80, minimum, initial, and 0.79, minimum, 3-year, certified by Cool Roof Rating Council.
 - 5. Color: White.
- B. Seaming Materials: As recommended by membrane manufacturer.
- C. Membrane Fasteners: As recommended and approved by membrane manufacturer.
- D. Flexible Flashing Material: Material recommended by membrane manufacturer.
- E. Through-Wall Flashing: Cold-applied, self-adhering, styrene-butadiene-styrene (SBS) modified rubberized asphalt sheet membrane bonded with high density cross-woven polyethylene film.
 - 1. Thickness: 47 mil, 0.047 inch, minimum.
 - 2. Width: 12 inches, minimum.
- F. Through-Wall Flashing with Termination Bar: At least 40 mil, 0.040 inch thick poly-reinforced membrane with extruded termination bar and drip-edge.
 - 1. Width: 18 inches, minimum.

2.03 COVER BOARDS

- A. Cover Boards: Glass-mat faced gypsum panels complying with ASTM C1177/C1177M.
 - 1. Thickness: 1/4 inch, fire-resistant.
 - 2. Products:
 - a. Georgia-Pacific; DensDeck: www.densdeck.com/#sle.
 - b. Gold Bond Building Products, LLC provided by National Gypsum Company; DEXcell Glass Mat Roof Board: www.goldbondbuilding.com/#sle.
 - c. Or Approved Equal.
 - d. Substitutions: See Section 016000 - Product Requirements.

2.04 INSULATION

- A. Polyisocyanurate (ISO) Board Insulation: Rigid cellular foam, complying with ASTM C1289.
 - 1. Classifications:
 - a. Type II: Faced with either cellulosic facers or glass fiber mat facers on both major surfaces of the core foam.
 - 1) Class 1 - Faced with glass fiber reinforced cellulosic facers on both major surfaces of the core foam.
 - 2) Compressive Strength: Classes 1-2-3, Grade 1, 16 psi (110 kPa), minimum.
 - 3) Thermal Resistance, R-value: At 1-1/2 inches thick; Class 1, Grades 1-2-3, 8.4 (1.48), minimum, at 75 degrees F.
 - 2. Board Size: 48 by 96 inches.
 - 3. Board Thickness: Refer to drawings
 - 4. Tapered Board: Slope as indicated; minimum thickness 5 inch at outer edge of sump; fabricate of fewest layers possible.
 - 5. Board Edges: Square.

2.05 ACCESSORIES

- A. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; elastomeric material compatible with membrane.
- B. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches wide; self adhering.
- C. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
- D. Membrane Adhesive: As recommended by membrane manufacturer.
- E. Insulation Adhesive: As recommended by insulation manufacturer.
- F. Sealants: As recommended by membrane manufacturer.
- G. Walkway Pads: Suitable for maintenance traffic, contrasting color or otherwise visually distinctive from roof membrane.
 - 1. Composition: Roofing membrane manufacturer's standard.
 - 2. Size: Manufacturer's standard size.
 - 3. Surface Color: White or Yellow.
 - 4. Location: provide path directly from roof hatch to all rooftop equipment. Provide walkway pad pathway around full perimeter of rooftop AHUs.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces and site conditions are ready to receive work.
- B. Verify deck is supported and secure.
- C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
- D. Verify deck surfaces are dry and free of snow or ice.
- E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and reglets are in place.

3.02 INSTALLATION, GENERAL

- A. Perform work in accordance with manufacturer's instructions, NRCA (RM), and NRCA (WM) applicable requirements.
- B. Do not apply roofing membrane during cold or wet weather conditions.
- C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
- D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
- E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.
- F. Coordinate this work with installation of associated counterflashings installed by other sections as the work of this section proceeds.

3.03 INSTALLATION - INSULATION, UNDER MEMBRANE

- A. Attachment of Insulation:
 - 1. Embed first layer of insulation in full bed of adhesive in accordance with roofing and insulation manufacturers' instructions.
 - 2. Mechanically fasten subsequent layer of insulation to deck in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.
- B. Cover Boards: Mechanically fasten cover boards in accordance with roofing manufacturer's instructions and FM (AG) Factory Mutual requirements.

- C. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.
- D. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.
- E. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
- F. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.
- G. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches.
- H. Do not install more insulation than can be covered with membrane in same day.

3.04 INSTALLATION - MEMBRANE

- A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
- B. Shingle joints on sloped substrate in direction of drainage.
- C. Apply adhesive to substrate at manufacturer's recommended rate. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
- D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.
- E. At intersections with vertical surfaces:
 - 1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
 - 2. Fully adhere flexible flashing over membrane and up to nailing strips.
- F. At gravel stops, extend membrane under gravel stop and to the outside face of the wall.
- G. Around roof penetrations, seal flanges and flashings with flexible flashing.
- H. Coordinate installation of roof drains and sumps and related flashings.

3.05 CLEANING

- A. See Section 017000 - Execution and Closeout Requirements for additional requirements.
- B. Remove bituminous markings from finished surfaces.
- C. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and comply with their documented instructions.
- D. Repair or replace defaced or damaged finishes caused by work of this section.

3.06 PROTECTION

- A. Protect installed roofing and flashings from construction operations.
- B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION 075400

SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fabricated sheet metal items, including flashings, counterflashings, and exterior penetrations.
- B. Break metal column wraps

1.02 REFERENCE STANDARDS

- A. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels (with Coil Coating Appendix); 2026.
- C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- E. CDA A4050 - Copper in Architecture - Handbook; Current Edition.
- F. SMACNA (ASMM) - Architectural Sheet Metal Manual; 2012.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.
- C. Samples: Submit two samples, 2 by 2 inches in size, illustrating metal finish color.

1.04 QUALITY ASSURANCE

- A. Perform work in accordance with SMACNA (ASMM) and CDA A4050 requirements and standard details, except as otherwise indicated.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
- B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sheet Metal Flashing and Trim:
 - 1. ALUCOBOND by 3A Composites USA: www.alucobondusa.com/#sle.
 - 2. Fairview Architectural LLC: www.fairview-na.com/#sle.
 - 3. Hickman Edge Systems: www.hickmanedgesystems.com/#sle.
 - 4. Metal Era
 - 5. McElroy Metals
 - 6. Peterson Aluminum
 - 7. Soprema, Inc: www.soprema.us/#sle.
 - 8. Tamlyn: www.tamlyn.com/#sle.
 - 9. Approved Equal
 - 10. Substitutions: See Section 016000 - Product Requirements.

2.02 SHEET MATERIALS

- A. Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal.

- B. Anodized Aluminum: ASTM B209/B209M, 3005 alloy, H12 or H14 temper; 0.032 inch thick; anodized finish of color as selected.
 - 1. Color Anodized Finish: AAMA 611, AA-M12C22A42/44, Class I, integrally or electrolytically colored anodic coating not less than 0.7 mil, 0.0007 inch thick.
 - a. Color: As selected by Architect from manufacturer's full colors.

2.03 PREFINISHED ALUMINUM SHEETS

- A. Aluminum Sheet Substrates: ASTM B209/B209M, alloy and temper as recommended by manufacturer for application.
- B. Superior Performance Organic Coating System: Comply with AAMA 2605 for aluminum preparation, pretreatment, primer and finish coat system; provide thermally cured 70-percent PVDF fluoropolymer systems; tested for weathering for 10 years with 5 delta units color change maximum.

2.04 FABRICATION

- A. Form sections true to shape, accurate in size, square, and free from distortion or defects.
- B. Form pieces in longest possible lengths.
- C. Hem exposed edges on underside 1/2 inch; miter and seam corners.
- D. Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.
- E. Fabricate corners from one piece with minimum 18-inch long legs; seam for rigidity, seal with sealant.
- F. Fabricate flashings to allow toe to extend 2 inches over roofing gravel. Return and brake edges.

2.05 FLASHING

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

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.
- B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

- A. Install starter and edge strips, and cleats before starting installation.
- B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil, 0.015 inch.

3.03 INSTALLATION

- A. Secure flashings in place using concealed fasteners, and use exposed fasteners only where permitted.
- B. Apply plastic cement compound between metal flashings and felt flashings.
- C. Fit flashings tight in place; make corners square, surfaces true and straight in planes, and lines accurate to profiles.
- D. Exterior Flashing Receivers: Install in accordance with manufacturer's recommendations, and in proper relationship with adjacent construction, and as follows:

END OF SECTION 076200

SECTION 077200 ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof hatches.

1.02 REFERENCE STANDARDS

- A. 29 CFR 1910.23 - Ladders; Current Edition.
- B. 29 CFR 1910.29 - Fall Protection Systems and Falling Object Protection - Criteria and Practices; Current Edition.
- C. 29 CFR 1926.502 - Fall protection systems criteria and practices; Current Edition.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Installation methods.
 - 4. Maintenance requirements.
- C. Shop Drawings: Submit detailed layout developed for this project and provide dimensioned location and number for each type of roof accessory.
- D. Warranty Documentation:
 - 1. Submit manufacturer warranty.
 - 2. Ensure that forms have been completed in Owner's name and registered with manufacturer.
 - 3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 ROOF HATCHES AND VENTS

- A. Roof Hatch Manufacturers:
 - 1. Babcock-Davis: www.babcockdavis.com/#sle.
 - 2. Bilco Company: www.bilco.com/#sle.
 - 3. Nystrom, Inc: www.nystrom.com/#sle.
 - 4. Approved Equal.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Frames and Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
 - 1. Insulation: Manufacturer's standard; 3 inch rigid glass fiber, located on outside face of curb.
 - 2. Curb Height: As indicated on drawings.
- C. Metal Covers: Flush, insulated, hollow metal construction.
 - 1. Capable of supporting 40 psf live load.
 - 2. Insulation: Manufacturer's standard 3 inch rigid glass fiber.
 - 3. Gasket: Neoprene, continuous around cover perimeter.
- D. Safety Railing System: Roof hatch safety rail system mounted directly to curb without penetration of roofing system.

- E. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
 - 1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf load.
 - 2. Hinges: Manufacturer's standard type.
 - 3. Hold open arm with manual release.
 - 4. Latch: Upon closing, engage latch automatically and reset manual release.
 - 5. Manual Release: Pull handle on interior and exterior.
 - 6. Locking: Padlock hasp on interior.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. See Section 077100 for information on roof specialties.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 CLEANING

- A. Clean installed work to like-new condition.

END OF SECTION 077200

SECTION 079200 JOINT SEALANTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nonsag gunnable joint sealants.
- B. Self-leveling pourable joint sealants.
- C. Joint backings and accessories.

1.02 REFERENCE STANDARDS

- A. ASTM C834 - Standard Specification for Latex Sealants; 2017 (Reapproved 2023).
- B. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications; 2024.
- C. ASTM C920 - Standard Specification for Elastomeric Joint Sealants; 2018 (Reapproved 2024).
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2016 (Reapproved 2023).
- E. ASTM C1248 - Standard Test Method for Staining of Porous Substrate by Joint Sealants; 2022.
- F. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials; 2022.
- G. UL 263 - Standard for Fire Tests of Building Construction and Materials; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturer's technical datasheets for each product to be used; include the following:
 - 1. Physical characteristics, including movement capability, VOC content, hardness, cure time, and color availability.
 - 2. List of backing materials approved for use with the specific product.
 - 3. Backing material recommended by sealant manufacturer.
 - 4. Substrates that product is known to satisfactorily adhere to and with which it is compatible.
 - 5. Substrates the product should not be used on.
- C. Product Data for Accessory Products: Submit manufacturer's technical data sheet for each product to be used, including physical characteristics, installation instructions, and recommended tools.
- D. Color Cards for Selection: Where sealant color is not specified, submit manufacturer's color cards showing standard colors available for selection.
- E. Samples for Verification: Where custom sealant color is specified, obtain directions from Architect and submit at least two physical samples for verification of color of each required sealant.
- F. Manufacturer's qualification statement.
- G. Installer's qualification statement.
- H. Executed warranty.

1.04 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for installed sealants and accessories that fail to achieve a watertight seal, exhibit loss of adhesion or cohesion, or do not cure. Complete forms in Owner's name and register with manufacturer.
- C. Extended Correction Period: Correct defective work within 2-year period commencing on Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nonsag Sealants:
 - 1. Dow: www.dow.com/#sle.
 - 2. Hilti, Inc: www.hilti.com/#sle.
 - 3. Pecora Corporation: www.pecora.com/#sle.
 - 4. Sika Corporation: usa.sika.com/#sle.
 - 5. Tremco Commercial Sealants & Waterproofing: www.tremcosealants.com/#sle.
- B. Self-Leveling Sealants:
 - 1. Bostik Inc: www.bostik-us.com/#sle.
 - 2. Dow: www.dow.com/#sle.
 - 3. Pecora Corporation: www.pecora.com/#sle.
 - 4. Sika Corporation: usa.sika.com/#sle.
 - 5. W. R. Meadows, Inc: www.wrmeadows.com/#sle.

2.02 JOINT SEALANT APPLICATIONS

- A. Scope:
 - 1. Exterior Joints:
 - a. Seal the following joints:
 - 1) Wall expansion and control joints.
 - 2) Joints between doors, windows, and other frames or adjacent construction.
 - 3) Joints between different exposed materials.
 - 2. Interior Joints:
 - a. Do not seal interior joints indicated on drawings as not sealed.
 - b. Seal the following joints:
 - 1) Joints between door frames and window frames and adjacent construction.
 - 2) In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, and piping penetrations.
 - 3) In sound-rated wall and ceiling assemblies, seal joints between wall assemblies and ceiling assemblies; between wall assemblies and other construction; between ceiling assemblies and other construction.
 - 3. Do Not Seal:
 - a. Intentional weep holes in masonry.
 - b. Joints indicated to be covered with expansion joint cover assemblies.
 - c. Joints where sealant is specified to be furnished and installed by manufacturer of product to be sealed.
 - d. Joints where sealant installation is specified in other sections.
 - e. Joints between suspended ceilings and walls.
- B. Sound-Rated Assemblies: Walls and ceilings identified as STC-rated, sound-rated, or acoustical.

2.03 JOINT SEALANTS - GENERAL

- A. Sealants and Primers: Provide products with acceptable levels of volatile organic compound (VOC) content; see Section 016116.
- B. Colors: As indicated on drawings.

2.04 NONSAG JOINT SEALANTS

- A. Nonstaining Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
 - 1. Movement Capability: Plus and minus 25 percent, minimum.
 - 2. Nonstaining to Porous Stone: Nonstaining to light-colored natural stone when tested in accordance with ASTM C1248.
 - 3. Dirt Pick-Up: Reduced dirt pick-up compared to other silicone sealants.

4. Color: To be selected by Architect from manufacturer's standard range.
 5. Products:
 - a. Dow; DOWSIL 790 Silicone Building Sealant: www.dow.com/#sle.
 - b. Dow; DOWSIL 791 Silicone Weatherproofing Sealant, Carbon Neutral: www.dow.com/#sle.
 - c. Dow; DOWSIL 795 Silicone Building Sealant, Carbon Neutral: www.dow.com/#sle.
 - d. Approved Equal.
- B. Silicone Sealant: ASTM C920, Grade NS, Use T; single component, explicitly approved by manufacturer for traffic exposure when recessed below traffic surface; not expected to withstand continuous water immersion.
1. Movement Capability: Plus 100 percent and minus 50 percent, minimum.
 2. Color: To be selected by Architect from manufacturer's standard range.
 3. Products:
 - a. Dow; DOWSIL NS Parking Structure Sealant: www.dow.com/#sle.
 - b. Dow; DOWSIL 888 Silicone Joint Sealant: www.dow.com/#sle.
 - c. Pecora Corporation; Pecora PCS: www.pecora.com/#sle.
 - d. Pecora Corporation; Pecora 301 NS (Non-Sag): www.pecora.com/#sle.
- C. Silicone Sealant: ASTM C920, Grade NS, Uses M and A; not expected to withstand continuous water immersion or traffic.
1. Movement Capability: Plus and minus 25 percent, minimum.
 2. Color: To be selected by Architect from manufacturer's standard range.
 3. Products:
 - a. Dow; DOWSIL 999-A Building and Glazing Sealant: www.dow.com/#sle.
 - b. Dow; DOWSIL 758 Silicone Weather Barrier Sealant: www.dow.com/#sle.
 - c. Momentive Performance Materials, Inc/GE Silicones; SSG4600 UltraGlaze - Silicone Structural Glazing Adhesive: www.siliconeforbuilding.com/#sle.
 - d. Pecora Corporation; Pecora 860: www.pecora.com/#sle.
- D. Mildew-Resistant Silicone Sealant: ASTM C920, Grade NS, Uses M and A; single component, mildew resistant; not expected to withstand continuous water immersion or traffic.
1. Color: White.
 2. Products:
 - a. Adfast USA Inc; ADSEAL KB 4800 Series: www.adfastcorp.com/#sle.
 - b. Pecora Corporation; Pecora 898 NST (Non-Staining Technology): www.pecora.com/#sle.
 - c. Sika Corporation; Sikasil GP: usa.sika.com/#sle.
 - d. Dow-Corning Corp; 786 .
- E. Acrylic Emulsion Latex: Water-based; ASTM C834, single component, nonstaining, nonbleeding, nonsagging; not intended for exterior use.
1. Color: To be selected by Architect from manufacturer's standard range.
 2. Products:
 - a. Pecora Corporation; AC-20 +Silicone: www.pecora.com/#sle.
 - b. Sherwin-Williams Company; 850A Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
 - c. Sherwin-Williams Company; 950A Siliconized Acrylic Latex Caulk: www.sherwin-williams.com/#sle.
 - d. Tremco Commercial Sealants & Waterproofing; Tremflex 834: www.tremcosealants.com/#sle.
- F. Acrylic Latex Sealant: ASTM C834; for use as acoustical sealant and in firestopping systems for expansion joints and through penetrations.
1. Color: To be selected by Architect from manufacturer's standard range.
 2. Fire Rated System: Complies with UL 263 and ASTM E119 with UL fire resistance classifications.

3. Products:
 - a. Pecora Corporation; AC-20 FTR (Fire and Temperature Rated):
www.pecora.com/#sle.

2.05 SELF-LEVELING JOINT SEALANTS

- A. Flexible Polyurethane Foam: Single component, gun grade, and low-expanding.
 1. Color: White.
 2. Products:
 - a. ADFAST Corporation; Adfoam Flex 1865: www.adfastcorp.com/#sle.
 - b. DAP Products Inc; DRAFTSTOP 812 Foam: www.dapspecline.com/#sle.
 - c. Tremco Commercial Sealants & Waterproofing; ExoAir Flex Foam:
www.tremcosealants.com/#sle.

2.06 ACCESSORIES

- A. Sealant Backing Materials, General: Materials placed in joint before applying sealants; assists sealant performance and service life by developing optimum sealant profile and preventing three-sided adhesion; type and size recommended by sealant manufacturer for compatibility with sealant, substrate, and application.
- B. Backing Tape: Self-adhesive polyethylene tape with surface that sealant will not adhere to and recommended by tape and sealant manufacturers for specific application.
- C. Masking Tape: Self-adhesive, nonabsorbent, nonstaining, removable without adhesive residue, and compatible with surfaces adjacent to joints and sealants.
- D. Joint Cleaner: Noncorrosive and nonstaining type, type recommended by sealant manufacturer; compatible with joint forming materials.
- E. Primers: Type recommended by sealant manufacturer to suit application; nonstaining.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that joints are ready to receive work.
- B. Verify that backing materials are compatible with sealants.
- C. Verify that backer rods are of the correct size.

3.02 PREPARATION

- A. Remove loose materials and foreign matter that could impair adhesion of sealant.
- B. Clean joints, and prime as necessary, in accordance with manufacturer's instructions.
- C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
- D. Mask elements and surfaces adjacent to joints from damage and disfigurement due to sealant work; be aware that sealant drips and smears may not be completely removable.

3.03 INSTALLATION

- A. Install this work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
- B. Provide joint sealant installations complying with ASTM C1193.
- C. Install acoustical sealant application work in accordance with ASTM C919.
- D. Measure joint dimensions and size joint backers to achieve the following, unless otherwise indicated:
 1. Width/depth ratio of 2:1.
 2. Neck dimension no greater than 1/3 of the joint width.
 3. Surface bond area on each side not less than 75 percent of joint width.
- E. Install bond breaker backing tape where backer rod cannot be used.

- F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags, and without getting sealant on adjacent surfaces.
- G. Do not install sealant when ambient temperature is outside manufacturer's recommended temperature range, or will be outside that range during the entire curing period, unless manufacturer's approval is obtained and instructions are followed.
- H. Nonsag Sealants: Tool surface concave, unless otherwise indicated; remove masking tape immediately after tooling sealant surface.

3.04 FIELD QUALITY CONTROL

- A. See Section 014000 - Quality Requirements for additional requirements.
- B. Remove and replace failed portions of sealants using same materials and procedures as indicated for original installation.

END OF SECTION 079200

**SECTION 081113
HOLLOW METAL DOORS AND FRAMES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Non-fire-rated hollow metal doors and frames.
- B. Hollow metal frames for wood doors.
- C. Fire-rated hollow metal doors and frames.
- D. Thermally insulated hollow metal doors with frames.

1.02 RELATED REQUIREMENTS

- A. Section 087100 - Door Hardware.
- B. Section 088000 - Glazing.
- C. Section 099000 - Painting

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors; 2026.
- C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100); 2023.
- D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames; 2025.
- E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.
- F. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.
- G. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.
- H. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- I. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- J. NAAMM HMMA 805 - Recommended Selection and Usage Guide for Hollow Metal Doors and Frames; 2012.
- K. NAAMM HMMA 830 - Hardware Selection for Hollow Metal Doors and Frames; 2002.
- L. NAAMM HMMA 831 - Hardware Locations for Hollow Metal Doors and Frames; 2024.
- M. NAAMM HMMA 840 - Guide Specifications for Receipt, Storage and Installation of Hollow Metal Doors and Frames; 2024.
- N. NAAMM HMMA 860 - Guide Specifications for Hollow Metal Doors and Frames; 2018.
- O. NAAMM HMMA 861 - Guide Specifications for Commercial Hollow Metal Doors and Frames; 2014.
- P. SDI 117 - Manufacturing Tolerances for Standard Steel Doors and Frames; 2026.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced standards/guidelines.

- C. Shop Drawings:
1. Elevations of each door and frame type
 2. Details for door core
 3. Details of doors, including vertical and horizontal edge details and metal thicknesses
 4. Locations of cutouts for glass and louvers
 5. Frame details for each frame type, including dimensioned profiles and metal thicknesses
 6. Mounting locations for hardware
 7. Thickness of reinforcement/preparations for hardware
 8. Details of anchorages, joints, field splices, and connections
 9. Details of accessories
 10. Details of moldings, removable stops, and glazing
 11. Fire ratings
 12. Finish

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Provide hollow metal doors and frames from SDI Certified manufacturer: <https://steeldoor.org/sdi-certified/#sle>.
- B. Maintain at project site copies of reference standards relating to installation of products specified.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with NAAMM HMMA 840 or ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion and adverse effects on factory applied painted finish.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Hollow Metal Doors and Frames:
1. Ceco Door, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 2. Curries, an Assa Abloy Group company: www.assaabloydss.com/#sle.
 3. Republic Doors, an Allegion brand: www.republicdoor.com/#sle.
 4. Steelcraft, an Allegion brand: www.allegion.com/#sle.
 5. Titan Metal Products, Inc: www.titanmetalproducts.com/#sle.

2.02 PERFORMANCE REQUIREMENTS

- A. Requirements for Hollow Metal Doors and Frames:
1. Steel Sheet: Comply with one or more of the following requirements; galvanized steel complying with ASTM A653/A653M, cold-rolled steel complying with ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel complying with ASTM A1011/A1011M, commercial steel (CS) Type B, for each.
 2. Accessibility: Comply with ICC A117.1 and ADA Standards.
 3. Exterior Door Top Closures: Flush end closure channel, with top and door faces aligned.
 4. Door Edge Profile: Manufacturers standard for application indicated.
 5. Typical Door Face Sheets: Flush.
 6. Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.
- B. Combined Requirements: If a particular door and frame unit is indicated to comply with more than one type of requirement, comply with the specified requirements for each type; for instance, an exterior door that is also indicated as being sound-rated must comply with the requirements specified for exterior doors and for sound-rated doors; where two requirements conflict, comply with the most stringent.

2.03 HOLLOW METAL DOORS

- A. Door Finish: Factory primed and field finished.
- B. Exterior Doors: Thermally insulated.
 - 1. Based on NAAMM HMMA Custom Guidelines:
 - a. Comply with guidelines of NAAMM HMMA 860 for Hollow Metal Doors and Frames.
 - b. Performance Level 3 - Heavy Duty, in accordance with NAAMM HMMA 805.
 - c. Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
 - d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - 2. Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.
 - 3. Door Thickness: 1-3/4 inches, nominal.

2.04 HOLLOW METAL FRAMES

- A. Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.
- B. Exterior Door Frames: Full profile/continuously welded type.
 - 1. Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
 - 2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - 3. Frame Finish: Factory primed and field finished.
 - 4. Weatherstripping: See Section 087100.
- C. Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
 - 1. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - 2. Frame Finish: Factory primed and field finished.
- D. Door Frames, Fire-Rated: Full profile/continuously welded type.
 - 1. Fire Rating: Same as door, labeled.
 - 2. Frame Metal Thickness: 16 gauge, 0.053 inch, minimum.
 - 3. Frame Finish: Factory primed and field finished.
- E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.
- F. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inches high to fill opening without cutting masonry units.
- G. Frames Wider than 48 inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

2.05 FINISHES

- A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

2.06 ACCESSORIES

- A. Glazing: As specified in Section 088000, factory installed.
- B. Astragals and Edges for Double Doors: Pairs of door astragals, and door edge sealing and protection devices.
 - 1. Provide surface mounted astragal to cover or fill space for full door height between pair of doors or door and adjacent jamb.
 - 2. Astragal Type: Split, two parts, and with automatic locking, cutouts for other door hardware, and sealing gasket.
- C. Silencers: Resilient rubber, fitted into drilled hole; provide three on strike side of single door, three on center mullion of pairs, and two on head of pairs without center mullions.
- D. Temporary Frame Spreaders: Provide for factory- or shop-assembled frames.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that opening sizes and tolerances are acceptable.
- C. Verify that finished walls are in plane to ensure proper door alignment.

3.02 INSTALLATION

- A. Install doors and frames in accordance with manufacturer's instructions and related requirements of specified door and frame standards or custom guidelines indicated.
- B. Coordinate frame anchor placement with wall construction.
- C. Install door hardware as specified in Section 087100.
- D. Coordinate installation of electrical connections to electrical hardware items.

3.03 TOLERANCES

- A. Clearances Between Door and Frame: Comply with related requirements of specified frame standards or custom guidelines indicated in accordance with SDI 117 or NAAMM HMMA 861.
- B. Maximum Diagonal Distortion: 1/16 inch measured with straight edge, corner to corner.

3.04 ADJUSTING

- A. Adjust for smooth and balanced door movement.
- B. Adjust sound control doors so that seals are fully engaged when door is closed.
- C. Test sound control doors for force to close, latch, and unlatch; adjust as necessary in compliance with requirements.

3.05 SCHEDULE

- A. Refer to Door and Frame Schedule on the drawings.

END OF SECTION 081113

**SECTION 081416
FLUSH WOOD DOORS**

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 081113 - Hollow Metal Doors and Frames.
- B. Section 087100 - Door Hardware.
- C. Section 088000 - Glazing.

1.02 REFERENCE STANDARDS

- A. AWI/AWMAC/WI (AWS) - Architectural Woodwork Standards, 2nd Edition; 2014, with Errata (2016).
- B. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards; 2021, with Errata.
- C. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Indicate door core materials and construction; veneer species, type and characteristics.
- C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling, blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
- D. Samples: Submit two samples of door veneer, 12 by 12 inches in size illustrating wood grain, stain color, and sheen.
- E. Warranty, executed in Owner's name.

1.04 QUALITY ASSURANCE

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Package, deliver and store doors in accordance with specified quality standard.
- B. Accept doors on site in manufacturer's packaging, and inspect for damage.
- C. Protect doors with resilient packaging sealed with heat shrunk plastic; do not store in damp or wet areas or areas where sunlight might bleach veneer; seal top and bottom edges with tinted sealer if stored more than one week, and break seal on site to permit ventilation.

1.06 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer's warranty on interior doors for the life of the installation. Complete forms in Owner's name and register with manufacturer.
 - 1. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Wood Veneer Faced Doors:
 - 1. Krieger Specialty Products: www.kriegerproducts.com/#sle.
 - 2. Algoma Hardwoods, Inc
 - 3. Buell Door Company.
 - 4. Eggers Industries, Architectural Door Division
 - 5. Graham Manufacturing Corp.
 - 6. VT Doors
 - 7. Substitutions: See Section 016000 - Product Requirements.

2.02 DOORS AND PANELS

- A. Doors: See drawings for locations and additional requirements.
 - 1. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
- B. Interior Doors: 1-3/4 inches thick unless otherwise indicated; flush construction.
 - 1. Provide solid core doors at each location.
 - 2. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with UL 10C - Positive Pressure; Underwriters Laboratories Inc (UL) or Intertek/Warnock Hersey (WHI) labeled without any visible seals when door is open.
 - 3. Wood veneer facing with factory transparent finish as indicated on drawings.

2.03 DOOR AND PANEL CORES

- A. Non-Rated Solid Core and 20 Minute Rated Doors: Type particleboard core (PC), plies and faces as indicated.
- B. Fire-Rated Doors: Mineral core type, with fire resistant composite core (FD), plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
- C. Sound-Rated Doors: Equivalent to type, with particleboard core (PC) construction as required to achieve STC rating specified; plies and faces as indicated above.

2.04 DOOR FACINGS

- A. Veneer Facing for Transparent Finish: White Maple, Premium Grade, plain sliced (flat cut), with book match between leaves of veneer, running match of spliced veneer leaves assembled on door or panel face.

2.05 DOOR CONSTRUCTION

- A. Fabricate doors in accordance with door quality standard specified.
- B. Cores Constructed with stiles and rails:
 - 1. Provide solid blocks at lock edge for hardware reinforcement.
 - 2. Provide solid blocking for other throughbolted hardware.
- C. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
- D. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
- E. Provide edge clearances in accordance with the quality standard specified.

2.06 FINISHES - WOOD VENEER DOORS

- A. Finish work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 5 - Finishing for grade specified and as follows:
 - 1. Transparent:
 - a. Stain: As selected by Architect.
 - b. Sheen: Flat.

2.07 ACCESSORIES

- A. Hollow Metal Door Frames: See Section 081113.
- B. Glazing: See Section 088000.
- C. Glazing Stops: Wood, of same species as door facing, butted corners; prepared for countersink style tamper proof screws.
- D. Door Hardware: See Section 087100.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.

- B. Verify that opening sizes and tolerances are acceptable.
- C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

- A. Install doors in accordance with manufacturer's instructions and specified quality standard.
- B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
- C. Use machine tools to cut or drill for hardware.
- D. Coordinate installation of doors with installation of frames and hardware.
- E. Coordinate installation of glazing.

3.03 TOLERANCES

- A. Comply with specified quality standard for fit and clearance tolerances.
- B. Comply with specified quality standard for telegraphing, warp, and squareness.

3.04 ADJUSTING

- A. Adjust doors for smooth and balanced door movement.
- B. Adjust closers for full closure.

END OF SECTION 081416

SECTION 084313
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed storefront, with vision glass.
- B. Aluminum doors and frames.
- C. Weatherstripping.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- B. Section 084413 - Glazed Aluminum Curtain Walls.
- C. Section 087100 - Door Hardware: Hardware items other than specified in this section.
- D. Section 088000 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS

- A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.
- B. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.
- C. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2015.
- D. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- G. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2026.
- H. ASTM E330/E330M - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2014 (Reapproved 2021).

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with installation of other components that comprise the exterior enclosure.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, door hardware, and internal drainage details.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related work, expansion and contraction joint location and details, and field welding required.

1.06 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.

- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Correct defective Work within a five year period after Date of Substantial Completion.
- C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
- D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Aluminum-Framed Storefronts:
 - 1. Kawneer North America: www.kawneer.com/#sle.
 - 2. Oldcastle BuildingEnvelope: www.oldcastlebe.com/#sle.
 - 3. Tubelite, Inc: www.tubeliteinc.com/#sle.
 - 4. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.

2.02 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING

- A. Front-Set Style, Thermally-Broken:
 - 1. Basis of Design: KAWNEER TRIFAB 451T THERMALLY BROKEN.
 - 2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
- B. Substitutions: See Section 016000 - Product Requirements.
 - 1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.03 BASIS OF DESIGN -- FRAMING FOR MONOLITHIC GLAZING

- A. Center-Set Style:
 - 1. Basis of Design: KAWNEER TRIFAB 450.
 - 2. Vertical Mullion Dimensions: 1-3/4 inches wide by 4-1/2 inches deep.
- B. Substitutions: See Section 016000 - Product Requirements.
 - 1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.04 BASIS OF DESIGN -- SWINGING DOORS

- A. Medium Stile, Insulating Glazing, Thermally-Broken:
 - 1. Basis of Design: See Door Types in Architectural Drawings.
 - 2. Thickness: 1-3/4 inches.
- B. Substitutions: See Section 016000 - Product Requirements.
 - 1. For any product not identified as "Basis of Design", submit information as specified for substitutions.

2.05 ALUMINUM-FRAMED STOREFRONT

- A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Finish: Class I color anodized.
 - a. Factory finish all surfaces that will be exposed in completed assemblies.
 - 2. Finish Color: As indicated on drawings.

3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 4. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without causing detrimental effect to system components, anchorages, and other building elements.
 7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.
 8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
- B. Performance Requirements
1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
 - a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
 2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.

2.06 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Framing members for interior applications need not be thermally broken.
 2. Glazing Stops: Flush.

2.07 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Sheet Aluminum: ASTM B209/B209M.
- C. Fasteners: Stainless steel.
- D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- E. Glazing Accessories: See Section 088000.

2.08 FINISHES

- A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A44 Electrolytically deposited colored anodic coating not less than 0.7 mils thick.
- B. Color: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other work.
- B. Verify that storefront wall openings and adjoining water-resistive and/or air barrier seal materials are ready to receive work of this section.

3.02 INSTALLATION

- A. Install wall system in accordance with manufacturer's instructions.

- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
- H. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- I. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

3.04 PROTECTION

- A. Protect installed products from damage until Date of Substantial Completion.

END OF SECTION 084313

SECTION 084413
GLAZED ALUMINUM CURTAIN WALLS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Aluminum-framed curtain wall, with vision glazing and infill panels.

1.02 RELATED REQUIREMENTS

- A. Section 051200 - Structural Steel Framing: Steel attachment members.
- B. Section 055000 - Metal Fabrications: Steel attachment devices.
- C. Section 079200 - Joint Sealants: Sealing joints between frames and adjacent construction.
- D. Section 084313 - Aluminum-Framed Storefronts: Entrance framing and doors.
- E. Section 088000 - Glazing.
- F. Section 122400 - Window Shades: Attachments to framing members.

1.03 REFERENCE STANDARDS

- A. AAMA 609 & 610 - Cleaning and Maintenance Guide for Architecturally Finished Aluminum; 2025.
- B. AAMA 611 - Specification for Anodized Architectural Aluminum; 2026.
- C. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site; 2026.
- D. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- E. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- F. ASTM E283/E283M - Standard Test Method for Determining Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen; 2026.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, internal drainage details, glazing, and infill.
- C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
- D. Samples: Submit two samples illustrating finished aluminum surface, glazing, infill panels, and glazing materials.
- E. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
- F. Design Data: Provide framing member structural and physical characteristics and engineering calculations, and identify dimensional limitations; include load calculations at points of attachment to building structure.
- G. Manufacturer's Qualification Statement.
- H. Installer's Qualification Statement.
- I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Handle products of this section in accordance with AAMA CW-10.

- B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.06 FIELD CONDITIONS

- A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 5-year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units. Complete forms in Owner's name and register with installer.
- C. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Glazed Aluminum Curtain Walls Manufacturers:
 - 1. **BASIS OF DESIGN:** Kawneer North America; 1600 System 1 Curtain Wall: www.kawneer.com
 - 2. Oldcastle Building Envelope: www.oldcastlebe.com/#sle.
 - 3. Tubelite, Inc: www.tubeliteinc.com/#sle.
 - 4. Trulite Glass & Aluminum Solutions, LLC: www.trulite.com/#sle.

2.02 CURTAIN WALL

- A. Aluminum-Framed Curtain Wall: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
 - 1. Outside glazed, with pressure plate and mullion cover, where indicated on drawings.
 - 2. Glazing Method: Field glazed system.
 - 3. Vertical Mullion Dimensions: 2-1/2 inches wide by 7-1/2 inches deep.
 - 4. Finish: Pigmented organic coatings.
 - a. Factory finish surfaces that will be exposed in completed assemblies.
 - b. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.
 - c. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
 - 5. Provide flush joints and corners, weathersealed, accurately fitted and secured; prepared to receive anchors; fasteners and attachments concealed from view; reinforced as required for imposed loads.
 - 6. Construction: Eliminate noises caused by wind and thermal movement, prevent vibration harmonics, and prevent "stack effect" in internal spaces.
 - 7. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
 - 8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.
 - 9. Preparation for Window Treatments: Provide reinforced interior horizontal head rail.
- B. Water Penetration Resistance on Manufactured Assembly: No uncontrolled water on indoor face when tested as follows:
 - 1. Test Pressure Differential: 10 psf.
- C. Air Leakage: 0.06 cfm/sq ft maximum leakage of wall area when tested in accordance with ASTM E283/E283M at 6.24 psf pressure difference across assembly.

2.03 COMPONENTS

- A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
 - 1. Cross-Section: As indicated on drawings.
- B. Glazing: See Section 088000.

2.04 MATERIALS

- A. Extruded Aluminum: ASTM B221 (ASTM B221M).
- B. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.
- C. Glazing Accessories: See Section 088000.

2.05 FINISHES

- A. Class I Color Anodized Finish: AAMA 611 AA-M12C22A42 Integrally colored anodic coating not less than 0.7 mils thick.
- B. Color: As indicated on drawings.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify dimensions, tolerances, and method of attachment with other related work.
- B. Verify that curtain wall openings and adjoining water-resistive and air barrier seal materials are ready to receive work of this section.
- C. Verify that anchorage devices have been properly installed and located.

3.02 INSTALLATION

- A. Install curtain wall system in accordance with manufacturer's instructions.
- B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
- C. Provide alignment attachments and shims to permanently fasten system to building structure.
- D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
- E. Provide thermal isolation where components penetrate or disrupt building insulation.
- F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
- G. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
- H. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES

- A. Maximum Variation from Plumb: 0.06 inch per 3 feet noncumulative or 0.5 inches per 100 feet, whichever is less.
- B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.
- C. Sealant Space Between Curtain Wall Mullions and Adjacent Construction: Maximum of 3/4 inch and minimum of 1/4 inch.

3.04 CLEANING

- A. Remove protective material from pre-finished aluminum surfaces.
- B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths, take care to remove dirt from corners, and wipe surfaces clean.

- C. Upon completion of installation, thoroughly clean aluminum surfaces in accordance with AAMA 609 & 610.

END OF SECTION 084413

SECTION 087100 DOOR HARDWARE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hardware for fire-rated doors.
- B. Electrically operated and controlled hardware.
- C. Lock cylinders for doors with balance of hardware specified in other sections.
- D. Thresholds.
- E. Smoke and draft control seals.
- F. Weatherstripping and gasketing.
- G. Padlocks

1.02 RELATED REQUIREMENTS

- A. Section 062000 - Finish Carpentry: Wood door frames.
- B. Section 079200 - Joint Sealants: Sealants for setting exterior door thresholds.
- C. Section 081113 - Hollow Metal Doors and Frames.
- D. Section 081116 - Aluminum Doors and Frames.
- E. Section 081416 - Flush Wood Doors.
- F. Section 084313 - Aluminum-Framed Storefronts: Door hardware, except as noted in section.
- G. Section 281000 - Access Control: Electronic access control devices.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. BHMA A156.1 - Standard for Butts and Hinges; 2025.
- C. BHMA A156.2 - Bored and Preamsembled Locks and Latches; 2022.
- D. BHMA A156.3 - Exit Devices; 2025.
- E. BHMA A156.4 - Door Closers and Pivots; 2024.
- F. BHMA A156.5 - Cylinders and Input Devices for Locks; 2020.
- G. BHMA A156.6 - Standard for Architectural Door Trim; 2021.
- H. BHMA A156.7 - Template Hinge Dimensions; 2022.
- I. BHMA A156.8 - Door Controls - Overhead Stops and Holders; 2021.
- J. BHMA A156.13 - Mortise Locks and Latches; 2022.
- K. BHMA A156.16 - Standard for Auxiliary Hardware; 2023.
- L. BHMA A156.19 - Power Assist and Low Energy Power Operated Swinging Doors; 2019.
- M. BHMA A156.21 - Thresholds; 2025.
- N. BHMA A156.22 - Standard for Gasketing; 2021.
- O. BHMA A156.28 - Standard for Recommended Practices for Mechanical Keying Systems; 2023.
- P. BHMA A156.115 - Hardware Preparation in Steel Doors and Frames; 2016.
- Q. BHMA A156.115W - Hardware Preparation in Wood Doors with Wood or Steel Frames; 2006.
- R. DHI (H&S) - Sequence and Format for the Hardware Schedule; 2019.
- S. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- T. ITS (DIR) - Directory of Listed Products; Current Edition.

- U. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- V. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).
- W. NFPA 105 - Standard for Smoke Door Assemblies and Other Opening Protectives; 2025.
- X. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; 2022.
- Y. UL (DIR) - Online Certifications Directory; Current Edition.
- Z. UL 10C - Standard for Positive Pressure Fire Tests of Door Assemblies; Current Edition, Including All Revisions.
- AA. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.
- BB. UL 1034 - Standard for Safety Burglary-Resistant Electrical Locking Mechanisms; Current Edition, Including All Revisions.
- CC. UL 1784 - Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the manufacture, fabrication, and installation of products that door hardware is installed on.
- B. Sequence installation to ensure facility services connections are achieved in an orderly and expeditious manner.
- C. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by affected installers and the following:
 - 1. Architect.
 - 2. Installer's Architectural Hardware Consultant (AHC).
 - 3. Hardware Installer.
 - 4. Owner's Security Consultant.
- D. Furnish templates for door and frame preparation to manufacturers and fabricators of products requiring internal reinforcement for door hardware.
- E. Keying Requirements Meeting:
 - 1. Schedule meeting at project site prior to Contractor occupancy.
 - 2. Attendance Required:
 - a. Contractor.
 - b. Owner.
 - c. Architect.
 - d. Owner's Security Consultant.
 - 3. Agenda:
 - a. Establish keying requirements for project.
 - b. Verify locksets and locking hardware are functionally correct for project requirements.
 - c. Verify that keying and programming complies with project requirements.
 - d. Establish keying submittal schedule and update requirements.
 - 4. Incorporate "Keying Requirements Meeting" decisions into keying submittal upon review of door hardware keying system including, but not limited to, the following:
 - a. Access control requirements.
 - b. Key control system requirements.
 - c. Schematic diagram of preliminary key system.
 - d. Flow of traffic and extent of security required.
 - 5. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.
 - 6. Deliver established keying requirements to manufacturers.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's catalog literature for each type of hardware, marked to clearly show products to be furnished for this project, and includes construction details, material descriptions, finishes, and dimensions and profiles of individual components.
- C. Shop Drawings - Door Hardware Schedule: A detailed listing that includes each item of hardware to be installed on each door.
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC).
 - 2. Comply with DHI (H&S) using door numbering scheme and hardware set numbers as indicated in Contract Documents.
 - a. Submit in vertical format.
 - 3. Include complete description for each door listed.
 - 4. Include manufacturer's and product names, and catalog numbers; include functions, types, styles, sizes and finishes of each item.
 - 5. Include account of abbreviations and symbols used in schedule.
- D. Shop Drawings - Electrified Door Hardware: Include diagrams for power, signal, and control wiring for electrified door hardware that include details of interface with building safety and security systems. Provide elevations and diagrams for each electrified door opening as follows:
 - 1. Prepared by or under supervision of Architectural Hardware Consultant (AHC) and Electrified Hardware Consultant (EHC).
 - 2. Elevations: Include front and back elevations of each door opening showing electrified devices with connections installed and an operations narrative describing how opening operates from either side at any given time.
 - 3. Diagrams: Include point-to-point wiring diagrams that show each device in door opening system with related colored wire connections to each device.
- E. Manufacturer's Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- F. Operation and Maintenance Data: Include data on operating hardware, lubrication requirements, and inspection procedures related to preventative maintenance.
 - 1. Include manufacturer's parts lists and templates.
- G. Keying Schedule:
 - 1. Submit three copies of Keying Schedule complying with requirements established during Keying Requirements Meeting unless otherwise indicated.
- H. Executed Warranty.
- I. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- J. Maintenance Materials and Tools: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Tools: One set of each special wrench or tool applicable for each different or special hardware component, whether supplied by hardware component manufacturer or not.

1.06 QUALITY ASSURANCE

- A. Standards for Fire-Rated Doors: Maintain one copy of each referenced standard on site, for use by Architect and Contractor.
- B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum three years of documented experience.
- C. Installer Qualifications: Company specializing in performing work of the type specified for commercial door hardware with at least three years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.
- B. Package hardware items individually; label and identify each package with door opening code to match door hardware schedule.

1.08 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide manufacturer warranty against defects in material and workmanship for period indicated, from Date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.
 - 1. Closers: Thirty years.
 - 2. Exit Devices:
 - a. Mechanical: Five years.
 - 3. Locksets:
 - a. Mechanical: Ten years.
 - 4. Cylinders: Three years.
 - 5. Other Hardware: One year.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.
- B. Provide individual items of single type, of same model, and by same manufacturer.
- C. Locks: Provide a lock for each door, unless it's indicated that lock is not required.
 - 1. Lock Function: Provide lock and latch function numbers and descriptions of manufacturer's Series. As indicated in hardware sets.
 - 2. Trim: Provide lever handle or pull trim on outside of each lock, unless otherwise indicated.
 - 3. Strikes:
 - a. Finish: To match lock or latch.
 - b. Curved-Lip Strikes: Provide as standard, with extended lip to protect frame, unless otherwise indicated.
 - c. Center Strike At Pairs of Doors: 7/8 inch (22.2 mm) lip.
- D. Closers:
 - 1. Provide door closer on each exterior door, unless otherwise indicated.
 - 2. Provide door closer on each fire-rated and smoke-rated door.
 - 3. Spring hinges are not an acceptable self-closing device, unless otherwise indicated.
- E. Overhead Stops and Holders (Door Checks):
 - 1. Provide stop for every swinging door, unless otherwise indicated.
 - 2. Overhead Stop is not required if positive stop feature is specified for door closer; positive stop feature of door closer is not an acceptable substitute for a stop, unless otherwise indicated.
 - 3. Overhead stop is not required if a floor or wall stop has been specified for the door.
- F. Drip Guards: Provide at head of outswinging exterior doors unless protected by roof or canopy directly overhead.
- G. Thresholds:
 - 1. Exterior Applications: Provide at each exterior door, unless otherwise indicated.
- H. Smoke and Draft Control Seals:
- I. Weatherstripping and Gasketing:
 - 1. Provide weatherstripping on each exterior door at head, jambs, and meeting stiles of door pairs, unless otherwise indicated.

2. Provide door bottom sweep on each exterior door, unless otherwise indicated.
- J. Electrically Operated and/or Controlled Hardware: Provide necessary power supplies, power transfer hinges, relays, and interfaces as required for proper operation; provide wiring between hardware and control components and to building power connection in compliance with NFPA 70.
- K. See Section 281000 for additional access control system requirements.
- L. Fasteners:
 1. Provide fasteners of proper type, size, quantity, and finish that comply with commercially recognized standards for proposed applications.
 - a. Aluminum fasteners are not permitted.
 - b. Provide phillips flat-head screws with heads finished to match door surface hardware unless otherwise indicated.
 2. Provide machine screws for attachment to reinforced hollow metal and aluminum frames.
 - a. Self-drilling (Tek) type screws are not permitted.
 3. Provide stainless steel machine screws and lead expansion shields for concrete and masonry substrates.
 4. Provide wall grip inserts for hollow wall construction.
 5. Fire-Resistance-Rated Applications: Comply with NFPA 80.
 - a. Provide wood or machine screws for hinges mortised to doors or frames, strike plates to frames, and closers to doors and frames.
 - b. Provide steel through bolts for attachment of surface mounted closers, hinges, or exit devices to door panels unless proper door blocking is provided.

2.02 PERFORMANCE REQUIREMENTS

- A. Provide door hardware products that comply with the following requirements:
 1. Applicable provisions of federal, state, and local codes.
 2. Accessibility: ADA Standards and ICC A117.1.
 3. Fire-Resistance-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
 4. Hardware on Fire-Resistance-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), testing firm acceptable to authorities having jurisdiction, or _____ as suitable for application indicated.
 5. Hardware for Smoke and Draft Control Doors (Indicated as "S" on Drawings): Provide door hardware that complies with local codes, and requirements of assemblies tested in accordance with UL 1784.
 6. Hardware Preparation for Steel Doors and Steel Frames: BHMA A156.115.
 7. Hardware Preparation for Wood Doors with Wood or Steel Frames: BHMA A156.115W.
 8. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified.

2.03 HINGES

- A. Manufacturers: Conventional butt hinges.
 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 2. Ives
 3. McKinney
- B. Manufacturers: Continuous hinges.
 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 2. ABH Mfg.
 3. Select Hinges
- C. Properties:
 1. Butt Hinges: As applicable to each item specified.
 - a. Template screw hole locations.

- b. Bearing assembly installed after plating.
 - c. Bearings: Exposed fully hardened bearings.
 - d. Bearing Shells: Shapes consistent with barrels.
 - e. Pins: Easily seated, non-rising pins.
 - 1) Fully plate hinge pins.
 - 2) Non-Removable Pins: Slotted stainless steel screws.
 - f. UL 10C listed for fire-resistance-rated doors.
- 2. Continuous Hinges: As applicable to each item specified.
 - a. Geared Continuous Hinges: As applicable to each item specified.
 - 1) Non-handed.
 - 2) Anti-spinning through-fastener.
 - 3) UL 10C listed for fire-resistance-rated doors.
 - (a) Metal Door Installation: Rated up to 90 minutes.
 - (b) Wood Door Installation: Rated up to 60 minutes.
 - 4) Sufficient size to permit door to swing 180 degrees
- D. Sizes: See Door Hardware Schedule.
 - 1. Hinge Length: 83 inches (2108 mm).
 - 2. Sufficient size to allow 180 degree swing of door.
- E. Finishes: See Door Hardware Schedule.
 - 1. Fully polish hinges; front, back, and barrel.
- F. Grades:
 - 1. Butt Hinges: Comply with BHMA A156.1 and BHMA A156.7 for templated hinges.
- G. Material: Base metal as indicated for each item by BHMA material and finish designation.
- H. Types:
 - 1. Butt Hinges: Include full mortise hinges.
 - 2. Continuous Hinges: Include geared hinges.
- I. Options: As applicable to each item specified.
 - 1. Provide electric power transfer (EPT) as listed in hardware sets.
- J. Quantities:
 - 1. Butt Hinges: Three (3) hinges per leaves up to 90 inches (2286 mm) in height. Add one (1) for each additional 30 inches (762 mm) in height or fraction thereof.
 - a. Hinge weight and size unless otherwise indicated in hardware sets:
 - 1) For doors up to 36 inches (914 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.134 inch (3.4 mm) and a minimum of 4-1/2 inches (114 mm) in height.
 - 2) For doors from 36 inches (914 mm) wide up to 42 inches (1067 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.145 inch (3.7 mm) and a minimum of 4-1/2 inches (114 mm) in height.
 - 3) For doors from 42 inches (1067 mm) wide up to 48 inches (1219 mm) wide and up to 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.
 - 4) For doors greater than 1-3/4 inches (44.5 mm) thick provide hinges with a minimum thickness of 0.180 inch (4.6 mm) and a minimum of 5 inches (127 mm) in height.
 - 2. Continuous Hinges: One per door leaf.
- K. Applications: At swinging doors.
 - 1. Provide non-removable pins at out-swinging doors with locking hardware and all exterior doors.
- L. Products:
 - 1. Butt Hinges:
 - a. Ball Bearing, Five (5) Knuckle.

2. Continuous Hinges:
 - a. Aluminum geared hinges.

2.04 EXIT DEVICES

- A. Manufacturers:
 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 2. Von Duprin
 3. Sargent
- B. Properties:
 1. Actuation: Full-length touchpad.
 2. Touchpads: 'T' style metal touchpads and rail assemblies with matching chassis covers end caps.
 3. Latch Bolts: Stainless steel deadlocking with 3/4 inch (19 mm) projection using latch bolt.
 4. Lever Design: Match project standard lockset trims.
 5. Cylinder: Include where cylinder dogging or locking trim is indicated.
 6. Strike as recommended by manufacturer for application indicated.
 7. Sound dampening on touch bar.
 8. Dogging:
 - a. Fire-Resistance-Rated Devices: Manual dogging not permitted.
 9. Touch bar assembly on wide style exit devices to have a 1/4 inch (6.3 mm) clearance to allow for vision frames.
 10. All exposed exit device components to be of architectural metals and "true" architectural finishes.
 11. Handing: Field-reversible.
 12. Fasteners on Back Side of Device Channel: Concealed - exposed fasteners not allowed.
 13. Vertical Latch Assemblies' Operation: Gravity, without use of springs.
- C. Grades: Complying with BHMA A156.3, Grade 1.
 1. Provide exit devices tested and certified by UL or by a recognized independent laboratory for mechanical operational testing to 10 million cycles minimum with inspection confirming Grade 1 Loaded Forces have been maintained.
- D. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.
- E. Options:
 1. Electrified Devices:
 - a. Latchbolt Retraction: Motorized latchbolt retraction.
 - b. Electrified Devices: Electrically controlled exterior trim
- F. Products:
 1. BEST, Precision 2000 Series.
 2. Von Duprin
 3. Sargent

2.05 ELECTRIC STRIKES

- A. Manufacturers:
 1. dormakaba: www.dormakaba.com/#sle.
- B. Properties:
 1. Provide UL (DIR) listed burglary-resistant devices.
 2. Provide UL 1034 compliant devices.
 3. Provide UL 10C compliant devices.
 4. Non-handed devices suitable for door frame material and scheduled lock configuration.
 5. Include transformer and rectifier as necessary for complete installation.
 6. Holding Force: 1,500 lbs (680.4 kg).
 7. Accommodating latch projections of 1/2 inch (12.7 mm) or 5/8 inch (16 mm).

- C. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.
- D. Options: As applicable to each item specified.
 - 1. Voltage: 24 VDC.
- E. Installation: Connect electric strikes into fire alarm where non-rated doors are scheduled to release with fire or sprinkler alarm condition.
- F. Products:
 - 1. RCI 0 Series (0161, 0162, F0162, 0163).
 - 2. RCI 2 Series (F2164, 2364).

2.06 LOCK CYLINDERS

- A. Manufacturers:
 - 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 - 2. Schlage
 - 3. Sargent
- B. Properties:
 - 1. Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.
 - a. Provide cylinders from same manufacturer as locking device.
 - b. Provide cams and/or tailpieces as required for locking devices.
 - c. Provide cylinders with appropriate small format interchangeable cores where indicated.
- C. Grades:
 - 1. Standard Security Cylinders: Comply with BHMA A156.5.
- D. Material:
 - 1. Manufacturer's standard corrosion-resistant brass alloy.
- E. Types: As applicable to each item specified.
- F. Applications: At locations indicated in hardware sets, and as follows
 - 1. As required for items with locking devices provided by other sections, including at elevator controls and cabinets.
 - a. When provisions for lock cylinders are referenced elsewhere in the Project Manual to this Section, provide compatible type of lock cylinder, keyed to building keying system, unless otherwise indicated.
- G. Products:
 - 1. SFIC Rim/Mortise

2.07 MORTISE LOCKS

- A. Manufacturers:
 - 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 - 2. Schlage
 - 3. Sargent
- B. Properties:
 - 1. Mechanical Locks: Manufacturer's standard.
 - a. Fitting modified ANSI A115.1 door preparation.
 - b. Door Thickness Coordination Fitting 1-3/4 inch (44 mm) to 2-1/4 inch (57 mm) thick doors.
 - c. Latch: Solid, one-piece, anti-friction, self-lubricating stainless steel.
 - 1) Latchbolt Throw: 3/4 inch (19 mm), minimum.
 - d. Auxiliary Deadlatch: One piece stainless steel, permanently lubricated.
 - e. Backset: 2-3/4 inch (70 mm).
 - f. Lever Trim:

- 1) Functionality: Allow the lever handle to move up to 45 degrees from horizontal position prior to engaging the latchbolt assembly.
 - 2) Strength: Locksets outside locked lever designed to withstand minimum 1,400 inch-lbs (158.2 Nm) of torque. In excess of that, a replaceable part will shear. Key from outside and/or inside lever will still operate lockset.
 - 3) Spindle: Designed to prevent forced entry from attacking of lever.
 - 4) Independent spring mechanism for each lever.
 - (a) Trim to be self-aligning and thru-bolted.
- C. Finishes: See Door Hardware Schedule.
1. Core Faces: Match finish of lockset.
- D. Grades:
1. Comply with BHMA A156.13, Grade 1, Security; Grade 2.
- E. Options:
1. Regulatory Compliance: As required by authorities having jurisdiction the State in which the Project is located.
- F. Products: Mortise locks, including standard and electrified types.
1. BEST, 45H Series.
 2. Schlage
 3. Sargent

2.08 CYLINDRICAL LOCKS

- A. Manufacturers:
1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 2. Schlage
 3. Sargent
- B. Properties:
1. Mechanical Locks:
 - a. Fitting modified ANSI A115.2 door preparation.
 - b. Door Thickness Fit: 1-3/8 inches (35 mm) to 2-1/4 inches (57 mm) thick doors.
 - c. Construction: Hub, side plate, shrouded rose, locking pin to be a one-piece casting with a shrouded locking lug.
 - 1) Through-bolted anti-rotational studs.
 - d. Cast stainless steel latch retractor with roller bearings for exceptionally smooth operation and superior strength and durability.
 - e. Bored Hole: 2-1/8 inch (54 mm) diameter.
 - f. Backset: 5 inches (127 mm) unless otherwise indicated.
 - g. Latch: Single piece tail-piece construction.
 - 1) Latchbolt Throw: 9/16 inch (14.3 mm), minimum.
 - h. Cylinders:
 - 1) Cylinder Core Types: Locks capable of supporting manufacturers' cores, as applicable.
 - (a) Small format interchangeable.
 - i. Lever Trim:
 - 1) Style: See Door Hardware Schedule.
 - 2) Functionality: Allow the lever handle to move up to 45 degrees from horizontal position prior to engaging the latchbolt assembly.
 - 3) Strength: Locksets outside locked lever designed to withstand minimum 1,400 inch-lbs (158.2 Nm) of torque. In excess of that, a replaceable part will shear. Key from outside and/or inside lever will still operate lockset.
 - 4) Independent spring mechanism for each lever.
 - (a) Contain lever springs in the main lock hub.
 - 5) Outside Lever Sleeve: Seamless one-piece construction.

- 6) Keyed Levers: Removable only after core is removed by authorized control key.
- 2. Electrified Locks: Same properties as standard locks, and as follows:
 - a. Voltage: 24 VDC.
 - b. Function: Electrically locked (Fail Safe) or unlocked (Fail Secure), as indicated for each lock in Door Hardware Schedule.
 - c. Temperature Control Module (TCM).
- C. Finishes: See Door Hardware Schedule.
 - 1. Core Faces: Match finish of lockset.
- D. Grades: Comply with BHMA A156.2, Grade 1, Series 4000, Operational Grade 1, Extra Heavy Duty.
 - 1. Durability: Passing 100 Million cycle tests verified by third party testing agency.
- E. Material: Manufacturer's standard for specified lock.
 - 1. Critical Latch and Chassis Components: Brass or corrosion-resistance treated steel.
 - 2. Outside Lever Sleeve: Hardened steel alloy.
- F. Options:
 - 1. Regulatory Compliance: As required by authorities having jurisdiction the State in which the Project is located.
- G. Products: Cylindrical locks, including mechanical and electrified types.
 - 1. BEST, 9K Series.

2.09 CLOSERS

- A. Manufacturers:
 - 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
 - 2. LCN
 - 3. Sargent
- B. Properties:
 - 1. Surface Mounted Closers: Manufacturer's standard.
 - a. Mechanism: Separate tamper-resistant adjusting valves for closing and latching speeds.
 - b. Hydraulic Fluid: All-weather type.
 - c. Arm Assembly: Standard for product specified.
 - 1) Material: Steel.
 - 2) Include hold-open, integral stop, or spring-loaded stop feature, as specified in Door Hardware Schedule.
 - 3) Parallel arm to be a heavy-duty rigid arm.
 - 4) Where "IS" or "S-IS" arms are specified in hardware sets, if manufacturer does not offer this arm provide a regular arm mount closer in conjunction with a heavy-duty overhead stop equal to a dormakaba 900 Series.
 - d. Covers:
 - 1) Type: Standard for product selected.
 - (a) Full.
 - 2) Material: Plastic.
 - 3) Finish: Painted.
 - 4) Attachment: Two-point flange mounting, dual-clamp friction fit closer cover.
- C. Grades:
 - 1. Closers: Comply with BHMA A156.4, Grade 1.
 - a. Underwriters Laboratories Compliance:
 - 1) Product Listing: UL (DIR) and ULC for use on fire-resistance-rated doors.
 - (a) UL 228 - Door Closers-Holders, With or Without Integral Smoke Detectors.
- D. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.

1. Devices listed with California Department of Forestry and Fire Protection, Office of the State Fire Marshal.
- E. Types:
 1. Rack-and-pinion, surface-mounted. 1-1/2 inches (38 mm) minimum bore.
- F. Installation:
 1. Mounting: Includes surface mounted and concealed, overhead mounted installations.
 2. Mount closers on non-public side of door and stair side of stair doors unless otherwise noted in hardware sets.
 3. At outswinging exterior doors, mount closer on interior side of door.
 4. Provide adapter plates, shim spacers, and blade stop spacers as required by frame and door conditions.
 5. Where an overlapping astragal is included on pairs of swinging doors, provide coordinator to ensure door leaves close in proper order.
- G. Products:
 1. Surface Mounted:
 - a. BEST, HD8000 Series Interior Doors
 - b. LCN
 - c. Sargent

2.10 SWINGING DOOR OPERATORS

- A. Manufacturers:
 1. Norton 6000 Series
 2. dormakaba: ED100LE
 3. LCN 4600
- B. Properties:
 1. Where automatic operators are scheduled, provide complete assemblies of controls, switches, power supplies, relays, and parts/material recommended and approved by the manufacturer of the automatic operator for each individual leaf. Control both doors with actuators simultaneously at pairs. Locate actuators, key switches, and other controls as directed by Architect.
 2. Actuators:
 - a. Hard-Wired Units: Wall-mounted and tamper-resistant.
 - 1) Normally open switch.
 - 2) Wave to Open
- C. Grades:
 1. Comply with BHMA A156.19.
 2. Underwriters Laboratories Compliance:
 - a. Product Listing: UL (DIR) and ULC for use on fire-resistance-rated doors.
 - b. United States: UL 325.
- D. Code Compliance: As required by authorities having jurisdiction in the State in which the Project is located.
- E. Options: As applicable to each item specified.
 1. Delayed action, adjustable with an independent valve.
 2. Advanced backcheck.
 3. Heavy-duty arms and knuckles/elbows.
 4. Adjustable, for force or angle of opening hold open.
 5. Cushion limit stay.
- F. Installation:
 1. Operator Actuators: Include required back boxes, mounting rings, accessories as needed for fixed unit installation.
- G. Products:

1. Norton 6000
2. dormakaba Architectural Hardware ED100LE Series
3. LCN 4630/4640

2.11 OVERHEAD STOPS AND HOLDERS

- A. Manufacturers:
 1. ABH Mfg.
 2. Hager Co
 3. Rixson
- B. Properties:
 1. Hold-Open Settings: At 85 degrees opening.
 - a. Selective on/off.
 - b. Provide nylon composites for proven friction resistance and durability.
 - c. Provide built-in cushion stop.
- C. Sizes: Manufacturer's standard for the application.
- D. Finishes:
 1. Arms and Brackets: Zinc-plated.
- E. Grades: As applicable to item specified.
 1. Comply with BHMA A156.8, Grade 1.
- F. Material: Base metal as indicated for each item by BHMA material and finish designation.
 1. Track Channel: Extruded aluminum alloy.
 2. Slide Block: Machined from solid brass alloy.
- G. Types:
 1. Concealed.
- H. Products:
 1. Concealed Overhead Stops and Holders:

2.12 PROTECTION PLATES

- A. Manufacturers:
 1. Burns Mfg..
 2. Hager Co.
 3. Burns Mfg.
- B. Properties:
 1. Plates:
 - a. Kick Plates: Provide along bottom edge of push side of every wood door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.
 - 1) Size: 10 inches (254 mm) high by 2 inch (51 mm) less door width (LDW) on push side of door.
 - b. Edges: Beveled, on four (4) unless otherwise indicated.
- C. Grades: Comply with BHMA A156.6.
- D. Material: As indicated for each item by BHMA material and finish designation.
 1. Metal Properties: Stainless steel.
 - a. Metal, Standard Duty: Thickness 0.050 inch (1.27 mm), minimum.
- E. Installation:
 1. Fasteners: Countersunk screw fasteners
- F. Products: Kick Plates

2.13 STOPS AND HOLDERS

- A. Manufacturers:
 1. Burns Mfg.

- 2. Hager Co
- 3. ABH Mfg.
- B. General: Provide overhead stop/holder when wall or floor stop is not feasible.
- C. Grades:
 - 1. Door Holders, Wall Bumpers, and Floor Stops: Comply with BHMA A156.16 and Resilient Material Retention Test as described in this standard.
- D. Material: Base metal as indicated for each item by BHMA material and finish designation.
- E. Types:
 - 1. Wall Bumpers: Bumper, concave, wall stop.
 - 2. Floor Stops: Provide with bumper floor stop.
- F. Installation:
 - 1. Non-Masonry Walls: Confirm adequate wall reinforcement has been installed to allow lasting installation of wall bumpers.
- G. Products:
 - 1. Wall Bumpers.
 - 2. Floor Stops.

2.14 THRESHOLDS

- A. Manufacturers:
 - 1. National Guard Products, Inc (NGP): www.ngpinc.com/#sle.
 - 2. Zero
 - 3. Pemko
- B. Properties:
 - 1. Threshold Surface: Fluted horizontal grooves across full width.
- C. Threshold Grades: Comply with BHMA A156.21.
- D. Types: As applicable to project conditions. Provide barrier-free type at every location where specified.
 - 1. Saddle Thresholds: Without thermal break.
- E. Products:

2.15 WEATHERSTRIPPING AND GASKETING

- A. Manufacturers:
 - 1. National Guard Products, Inc (NGP): www.ngpinc.com/#sle.
 - 2. Zero
 - 3. Pemko
- B. Properties:
 - 1. Adhesive-Backed Perimeter Gasketing: Silicone gasket material applied to frame with self-adhesive.
 - 2. Door Sweeps: Neoprene gasket material held in place by flat aluminum housing or flange; surface mounted to face of door with screws.
- C. Grades: Comply with BHMA A156.22.
- D. Products:
 - 1. Weatherstripping: See Door Hardware Schedule.
 - 2. Door Bottom Seals:
 - a. Door Sweeps: See Door Hardware Schedule.

2.16 KEYS AND CORES

- A. Manufacturers:
 - 1. BEST, dormakaba Group: www.bestaccess.com/#sle.
- B. Properties: Complying with guidelines of BHMA A156.28.

1. Provide small format interchangeable core.
 2. Provide keys and cores keyed into new CORMAX system.
 3. Keying Schedule: Arrange for a keying meeting, with Architect, Owner and hardware supplier, and other involved parties to ensure locksets and locking hardware, are functionally correct and keying complies with project requirements.
 4. Keying: Master keyed.
 5. Include construction keying and control keying with removable core cylinders.
 6. Do not make brass construction cores and construction control and operating keys a part of Owner's permanent keying system, nor furnish in the same keyway (or key section) as Owner, permanent keying system.
 7. Key to new keying system.
 8. Supply keys in following quantities:
 - a. Grand Master Keys: 1 each.
 - b. Master Keys: 4 each.
 - c. Construction Master Keys: 6 each.
 - d. Construction Keys: 15 each.
 - e. Construction Control Keys: 2 each.
 - f. Change Keys: 2 each for each keyed core.
 9. Provide key collection envelopes, receipt cards, and index cards in quantity suitable to manage number of keys.
 10. Deliver keys with identifying tags to Owner by security shipment direct from manufacturer.
 11. Permanent Keys and Cores: Stamped with applicable key marking for identification. Do not include actual key cuts within visual key control marks or codes. Stamp permanent keys "Do Not Duplicate."
 12. Include installation of permanent cores and return construction cores to hardware supplier. Construction cores and keys to remain property of hardware supplier.
- C. Products: Permanent Keys and Cores.
1. Patented:
 - a. CORMAX.

2.17 FINISHES

- A. Finishes: Identified in Hardware Sets.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that doors and frames are ready to receive this work; labeled, fire-rated doors and frames are properly installed, and dimensions are as indicated on shop drawings.
- B. Correct all defects prior to proceeding with installation.
- C. Verify that electric power is available to power operated devices and of correct characteristics.

3.02 INSTALLATION

- A. Install hardware in accordance with manufacturer's instructions and applicable codes.
- B. Install hardware using the manufacturer's fasteners provided. Drill and tap all screw holes located in metallic materials. Do not use "Riv-Nuts" or similar products.
- C. Install hardware on fire-rated doors and frames in accordance with applicable codes and NFPA 80.
- D. Install hardware for smoke and draft control doors in accordance with NFPA 105.
- E. Use templates provided by hardware item manufacturer.
- F. Do not install surface mounted items until application of finishes to substrate are fully completed.
- G. Wash down masonry walls and complete painting or staining of doors and frames.

- H. Complete finish flooring prior to installation of thresholds.
- I. Door Hardware Mounting Heights: Distance from finished floor to center line of hardware item. As indicated in following list; unless noted otherwise in Door Hardware Schedule or on drawings.
 - 1. Mounting heights in compliance with ADA Standards:
 - a. Locksets: 40-5/16 inch (1024 mm).
 - b. Push Plates/Pull Bars: 42 inch (1067 mm).
 - c. Deadlocks (Deadbolts): 48 inch (1219 mm).
 - d. Exit Devices: 40-5/16 inch (1024 mm).
 - e. Door Viewer: 43 inch (1092 mm); standard height 60 inch (1524 mm).
- J. Set exterior door thresholds with full-width bead of elastomeric sealant at each point of contact with floor providing a continuous weather seal; anchor thresholds with stainless steel countersunk screws.
- K. Include in installation for existing doors and frames any necessary field modification and field preparation of doors and frames for new hardware. Provide necessary fillers, reinforcements, and fasteners for mounting new hardware and to cover existing door and frame preparations.

3.03 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of Section 014000 - Quality Requirements

3.04 ADJUSTING

- A. Adjust work under provisions of Section 017000 - Execution and Closeout Requirements.
- B. Adjust hardware for smooth operation.
- C. Adjust gasketing for complete, continuous seal; replace if unable to make complete seal.

3.05 CLEANING

- A. Clean finished hardware in accordance with manufacturer's written instructions after final adjustments have been made.
- B. Clean adjacent surfaces soiled by hardware installation activities.
- C. Replace items that cannot be cleaned to manufacturer's level of finish quality at no additional cost.
- D. See Section 017419 - Construction Waste Management and Disposal, for additional requirements.

3.06 PROTECTION

- A. Protect finished Work under provisions of Section 017000 - Execution and Closeout Requirements.
- B. Do not permit adjacent work to damage hardware or finish.

Option list

Code:	Name:
D_FunctionCode	Storeroom Function
SPA_Arm	SPA
CORMAX_CoreType	CORMAX
L_Function	Privacy Function
NRP	Non-Removeable Pin
N_FunctionCode	Passage Function
DS_Arm	Door Saver
CSK	CounterSunk Holes

S_TrimStyle	S Rose
1702	Exit only, dummy trim
VIBE_Option	Visual Indicator Both Sides
1703	Key retracts latchbolt
AB_FunctionCode	Office Function
15	15 Lever
4908	Key controls lever/knob
AF80P_Arm	Tri-Pack Arm
IS_Arm	Inswing Stop Arm
4914	Lever/knob always active
SPAT_Arm	Super Parallel Arm Thumbturn Hold-Open
LD_DeviceSuffix	Less Dogging

Finish list

Code:	Name:
622	Flat Black Coated
689	Aluminum
AL	Anodized Aluminum
622	Powder-Coated Matte Black
626	Chromium plated, satin
BSP	Black suede powder coat
693	Black
630	Satin Stainless Steel
BK	Black Anodized

Specification Report

Set #1

Doors: E100

2.0	Continuous Hinge	661 HD UL	BK	BES
1.0	Exit Device	3RO 2203 LD 1703A	622	PRE
1.0	Exit Device	3RO 2201 LD	622	PRE
1.0	Rim Cylinder	12E7 2 CORMAX	622	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	VR166	630	RCI
1.0	In-line Power Controller	ICEPK		RCI
2.0	Overhead Concealed Stop	1023SL	622	ABH
1.0	Door Closer	HD8016 SPA	693	BES
1.0	Low Energy Operator	6000	BSP	NOR
1.0	Threshold	896NDKB LAR		NGP
2.0	Sweep	200N LAR	B	NGP
1.0	Automatic Door Control Switches	704		

NOTE: Doors normally closed and locked unless scheduled to be unlocked via access control. When unlocked, use of actuator triggers operator to open LHR leaf along with LHR leaf of opening 100. When locked, valid credential momentarily releases electric strike and triggers operator to open LHR leaf and LHR leaf of opening 100. Free egress at all times. LHR active leaf. Fail secure. Gasket by door/frame manufacturer.

Set #2

Doors: 100

2.0	Continuous Hinge	661 HD UL	BK	BES
2.0	Dummy Touchbar	671DR	622	PRE
2.0	Exit Trim	1702 A	622	PRE
2.0	Overhead Concealed Stop	1023SL	622	ABH
1.0	Door Closer	HD8016 SPA	693	BES
1.0	Low Energy Operator	6000	BSP	NOR
1.0	Automatic Door Control Switches	704		

NOTE: Doors normally closed and unlocked. Use of actuator on push side of opening triggers operator to open LHR leaf along with LHR leaf of opening E100. Free egress at all times. LHR active leaf. Fail secure. Gasket by door/frame manufacturer.

Set #3

Doors: E120

1.0	Continuous Hinge	661 HD UL	AL	BES
1.0	Exit Device	3RO 2103 4903A		PRE
1.0	Rim Cylinder	12E7 2 CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	0162	630	RCI
1.0	Overhead Concealed Stop	1023SL	689	ABH
1.0	Door Closer	HD8016 SPA	689	BES
1.0	Threshold	425E LAR		NGP
1.0	Sweep	200N LAR	A	NGP

NOTE: Door normally closed and locked. Valid credential momentarily releases electric strike for ingress. Emergency ingress via key override. Free egress at all times. Card reader and power supply by others. Gasket by door/frame manufacturer.

Set #4

Doors: E118

4.0	Hinge	FBB191 4.5X4.5 NRP	630	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	F2164	630	RCI
1.0	Overhead Concealed Stop	1023	630	ABH
1.0	Door Closer	HD8016 SPA	689	BES
1.0	Threshold	425E LAR		NGP
1.0	Gasketing	700NA		NGP
1.0	Sweep	200N LAR	A	NGP

NOTE: Door normally closed and locked. Valid credential momentarily unlocks door for ingress. Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #5

Doors: S2-2

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Exit Device	3RO 2103 4903A		PRE
1.0	Rim Cylinder	12E7 2 CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	0162	630	RCI
1.0	Door Closer	HD8016 AF80P	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

NOTE: Door normally closed and locked. Valid credential momentarily unlocks door for ingress.

Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #6

Doors: 203-1

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Exit Device	3RO 2103 4903A		PRE
1.0	Rim Cylinder	12E7 2 CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	0162	630	RCI
1.0	Overhead Concealed Stop	1023	630	ABH
1.0	Door Closer	HD8016 SPA	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Gasketing	5050 C		NGP

NOTE: Door normally closed and locked. Valid credential momentarily unlocks door for ingress.
Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #7

Doors: 214

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Exit Device	3RO 2103 4903A		PRE
1.0	Exit Device	3RO 2101		PRE
1.0	Rim Cylinder	12E7 2 CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	VR166	630	RCI
2.0	Door Closer	HD8016 SPA	689	BES
2.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

NOTE: Doors normally closed and locked. Valid credential momentarily unlocks active leaf for ingress.
Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #8

Doors: 118

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	F2164	630	RCI
1.0	Door Closer	HD8016 AF80P	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

NOTE: Door normally closed and locked. Valid credential momentarily unlocks door for ingress.
Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #9

Doors: 119

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	F2164	630	RCI
1.0	Door Closer	HD8016 DS	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Gasketing	5050 C		NGP

NOTE: Door normally closed and locked. Valid credential momentarily unlocks door for ingress.
Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #10

Doors: 205-1, 205-2

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Electric Strike	F2164	630	RCI
1.0	Door Closer	HD8016 IS	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Gasketing	5050 C		NGP

NOTE: Door normally closed and locked. Valid credential momentarily unlocks door for ingress.
Emergency ingress via key override. Free egress at all times. Card reader and power supply by others.

Set #11

Doors: 120

1.0	Continuous Hinge	661 HD UL	BK	BES
1.0	Exit Device	3RO 2108 4908A	622	PRE
1.0	Rim Cylinder	12E7 2 CORMAX	622	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Overhead Concealed Stop	1023SL	622	ABH
1.0	Door Closer	HD8016 SPA	693	BES

NOTE: Gasket by door/frame manufacturer.

Set #12

Doors: 102D

1.0	Continuous Hinge	661 HD UL	BK	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	622	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Wall Stop	AB403	626	ABH

NOTE: Gasket by door/frame manufacturer.

Set #13

Doors: 102C-1, 106, 107, 114

1.0	Continuous Hinge	661 HD UL	BK	BES
1.0	Cylindrical Lock	9K 3 0 N 15 D	622	BES
1.0	Overhead Concealed Stop	1023SL (opening 114)	622	ABH
1.0	Wall Stop	AB403	626	ABH

NOTE: Gasket by door/frame manufacturer.

Set #14

Doors: 115, 116, 117-1, 117-2

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Exit Device	3RO 2108 4908A	630	PRE
1.0	Rim Cylinder	12E7 2 CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Door Closer	HD8016 SPAT	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #15

Doors: S2-1

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Exit Device	3RO 2114 4914A	630	PRE
1.0	Door Closer	HD8016 SPA	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #16

Doors: 203-2

4.0	Hinge	FBF179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Exit Device	3RO 2114 4914A	630	PRE
1.0	Door Closer	HD8016 AF80P	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #17

Doors: 220, 102B, 110

4.0	Hinge	FBF179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Mortise Lock	45H 0 L 15 S VIBE	626	BES
1.0	Door Closer	HD8016 AF80P	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #18

Doors: 216, 217, 218, 102, 103, 108, 113

4.0	Hinge	FBF179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 AB 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #19

Doors: 219, 109

4.0	Hinge	FBF179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Door Closer	HD8016 AF80P	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #20

Doors: 207-1, 207-2, ELEV

4.0	Hinge	FBF179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Overhead Concealed Stop	1023	630	ABH

1.0	Gasketing	5050 C		NGP

Set #21

Doors: 215

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #22

Doors: 104

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 7 D 15 D CORMAX	626	BES
1.0	Construction Core	7190224 (7p)		BES
1.0	Door Closer	HD8016 SPA	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #23

Doors: 112

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 0 N 15 D	626	BES
1.0	Door Closer	HD8016 IS	689	BES
1.0	Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0	Gasketing	5050 C		NGP

Set #24

Doors: 208, 210-2, 211, 213-2, 102A, 102C-2

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 0 N 15 D	626	BES
1.0	Wall Stop	AB403	626	ABH
1.0	Gasketing	5050 C		NGP

Set #25

Doors: 209-2, 212-2

4.0	Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0	Cylindrical Lock	9K 3 0 N 15 D	626	BES
1.0	Overhead Concealed	1023	630	ABH

Stop			
1.0 Gasketing	5050 C		NGP

Set #26

Doors: 221, 222, 105, 111

4.0 Hinge	FBB179 4.5X4.5 (NRP as req'd)	652	BES
1.0 Kick Plate	KP50 CSK 10" Door Width less 2"	630	BRN
1.0 Pull Plate	AB102_x_AB70C	630	ABH
1.0 Push Plate	AB70C	630	ABH
1.0 Door Closer	HD8016 AF80P	689	BES
1.0 Wall Stop	AB403	626	ABH
1.0 Gasketing	5050 C		NGP

Set #27

Doors: 204, 206

4.0 Hinge	FBB179 5X4.5 (NRP as req'd)	652	BES
1.0 Cylindrical Lock	9K 3 7 AB 15 D CORMAX	626	BES
1.0 Construction Core	7190224 (7p)		BES
1.0 Wall Stop	AB403	626	ABH
1.0 Gasketing	5050 C		NGP

Set #28

Doors: 209-1, 210-1, 212-1, 213-1

4.0 Hinge	FBB179 5X4.5 (NRP as req'd)	652	BES
1.0 Cylindrical Lock	9K 3 0 N 15 D	626	BES
1.0 Wall Stop	AB403	626	ABH
1.0 Gasketing	5050 C		NGP

END OF SECTION

SECTION 088000 GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Insulating glass units
- B. Glazing units.
- C. Glazing compounds.

1.02 RELATED REQUIREMENTS

- A. Section 079200 - Joint Sealants: Sealants for other than glazing purposes.
- B. Section 081113 - Hollow Metal Doors and Frames: Glazed lites in doors.
- C. Section 081416 - Flush Wood Doors: Glazed lites in doors.
- D. Section 084313 - Aluminum-Framed Storefronts: Glazing provided as part of storefront assembly.
- E. Section 084413 - Glazed Aluminum Curtain Walls: Glazing provided as part of wall assembly.
- F. Section 102800 - Toilet Accessories: Mirrors.

1.03 REFERENCE STANDARDS

- A. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005 (Reapproved 2019).
- B. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- C. ASTM C1048 - Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass; 2025.
- D. ASTM C1193 - Standard Guide for Use of Joint Sealants; 2025.
- E. ASTM C1376 - Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass; 2021a.
- F. ASTM E1300 - Standard Practice for Determining Load Resistance of Glass in Buildings; 2024.
- G. ASTM E2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2019.
- H. GANA (GM) - GANA Glazing Manual; 2022.
- I. GANA (SM) - GANA Sealant Manual; 2008.
- J. NFRC 100 - Procedure for Determining Fenestration Product U-factors; 2023.
- K. NFRC 200 - Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence; 2023.
- L. NFRC 300 - Test Method for Determining the Solar Optical Properties of Glazing Materials and Systems; 2026.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data on Insulating Glass Unit and Glazing Unit Glazing Types: Provide structural, physical and environmental characteristics, size limitations, special handling and installation requirements.
- C. Product Data on Glazing Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements, and identify available colors.
- D. Samples: Submit two samples 12 by 12 inch in size of glass units.
- E. Certificate: Certify that products of this section meet or exceed specified requirements.

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

1.05 QUALITY ASSURANCE

- A. Perform Work in accordance with GANA (GM) and FGMA Sealant Manual for glazing installation methods.
- B. Installer Qualifications: Company specializing in performing work of type specified, with minimum 3 years of documented experience.

1.06 FIELD CONDITIONS

- A. Do not install glazing when ambient temperature is less than 40 degrees F.
- B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.07 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Insulating Glass Units: Provide a ten (10) year manufacturer warranty to include coverage for seal failure, interpane dusting or misting, including providing products to replace failed units.
- C. Laminated Glass: Provide a ten (10) year manufacturer warranty to include coverage for delamination, including providing products to replace failed units.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS - EXTERIOR GLAZING ASSEMBLIES

- A. Provide type and thickness of exterior glazing assemblies to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of glass.
 - 1. Comply with ASTM E1300 for design load resistance of glass type, thickness, dimensions, and maximum lateral deflection of supported glass.
 - 2. Provide glass edge support system sufficiently stiff to limit the lateral deflection of supported glass edges to less than 1/175 of their lengths under specified design load.
 - 3. Glass thicknesses listed are minimum.
- B. Weather-Resistive Barrier Seals: Provide completed assemblies that maintain continuity of building enclosure water-resistive barrier, vapor retarder, and/or air barrier.
 - 1. In conjunction with weather barrier related materials described in other sections, as follows:
 - 2. To utilize inner pane of multiple pane insulating glass units for continuity of vapor retarder and/or air barrier seal.
 - 3. To maintain a continuous vapor retarder and/or air barrier throughout glazed assembly from glass pane to heel bead of glazing sealant.
- C. Thermal and Optical Performance: Provide exterior glazing products with performance properties as indicated. Performance properties are in accordance with manufacturer's published data as determined with the following procedures and/or test methods:
 - 1. Center of Glass U-Factor: Comply with NFRC 100 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
 - 2. Center of Glass Solar Heat Gain Coefficient (SHGC): Comply with NFRC 200 using Lawrence Berkeley National Laboratory (LBNL) WINDOW 7 computer program.
 - 3. Solar Optical Properties: Comply with NFRC 300 test method.

2.02 GLASS MATERIALS

- A. Float Glass: Provide float glass based glazing unless otherwise indicated.
 - 1. Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality - Q3.
 - 2. Kind HS - Heat-Strengthened Type: Complies with ASTM C1048.
 - 3. Kind FT - Fully Tempered Type: Complies with ASTM C1048.

4. Tinted Type: ASTM C1036, Class 2 - Tinted, Quality - Q3, with color and performance characteristics as indicated.
5. Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

2.03 INSULATING GLASS UNITS

- A. Manufacturers:
 1. Guardian Glass, LLC: www.guardianglass.com/#sle.
 2. Pilkington North America Inc: www.pilkington.com/na/#sle. Pilkington North America Inc: www.pilkington.com/na/#sle.
 3. Viracon, Apogee Enterprises, Inc: www.viracon.com/#sle.
 4. Vitro Architectural Glass (formerly PPG Glass): www.vitroglazings.com/#sle.
 5. Or Approved Equal.
 6. Substitutions: See Section 016000 - Product Requirements.
- B. Insulating Glass Units: Types as indicated.
 1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
 2. Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
 3. Spacer Color: Black.
 4. Edge Seal:
 - a. Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.
 - b. Color: Black.
 5. Purge interpane space with dry air, hermetically sealed.
- C. Type IG-1 - Insulating Glass Units: Vision glass, double glazed hermetically sealed.
 1. Applications: Exterior glazing unless otherwise indicated.
 2. Space between lites filled with argon.
 3. Outboard Lite: 1/4 inch thick.
 - a. Tint: Clear.
 - b. Coating: Low-E (solar control type), on #2 surface.
 - 1) BASIS OF DESIGN: Vitro Architectural Glass Solarban 90
 4. Warm-edge spacer.
 5. Inboard Lite: 1/4 inch thick.
 - a. Tint: Clear.
 6. Total Thickness: 1 inch.
 7. Thermal Transmittance (U-Value): 0.24 minimum
- D. Type IG-2 - Insulating Glass Units: Spandrel glazing.
 1. Applications: Exterior spandrel glazing unless otherwise indicated.
 2. Space between lites filled with air.
 3. Outboard Lite: Annealed float glass, 1/4 inch thick, minimum.
 - a. Tint: Clear.
 - b. Coating: Same as on vision units, on #2 surface.
 4. Inboard Lite: Heat-strengthened float glass, 1/4 inch thick.
 - a. Tint: Clear.
 - b. Opacifier: Ceramic frit, on #4 surface.
 - c. Opacifier Color: Warm Gray; Final color to be selected by architect from manufacturer's full line. Intended to visually match IG-1.
 5. Total Thickness: 1 inch.

2.04 GLAZING UNITS

- A. Type G-1 - Monolithic Interior Vision Glazing:

1. Applications: Interior glazing unless otherwise indicated.
 2. Glass Type: Fully tempered float glass.
 3. Tint: Clear.
 4. Thickness: 1/4 inch, nominal.
- B. Type M-1 - Transparent One-Way Mirror: Mirror quality float glass with pyrolytic (hard coat) type coating located on high light level surface of glass; ASTM C1376.
1. Applications: Control Room (as indicated on drawings)
 2. Thickness: 1/4 inch.
 3. Glass Tint: Grey.
 4. Glass Type: Annealed.
 5. Manufacturers:
 - a. Pilkington North America Inc; Mirropane: www.pilkington.com/na/#sle.
 - b. Or Approved Equal.
 - c. Substitutions: See Section 016000 - Product Requirements.

2.05 ACCESSORIES

- A. Setting Blocks: Silicone, with 80 to 90 Shore A durometer hardness; ASTM C864 Option II. Length of 0.1 inch for each square foot of glazing or minimum 4 inch by width of glazing rabbet space minus 1/16 inch by height to suit glazing method and pane weight and area.
- B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness; ASTM C864 Option II. Minimum 3 inch long by one half the height of the glazing stop by thickness to suit application, self adhesive on one face.
- C. Glazing Tape, Back Bedding Mastic Type: Preformed, butyl-based, 100 percent solids compound with integral resilient spacer rod applicable to application indicated; 5 to 30 cured Shore A durometer hardness; coiled on release paper; black color.
1. Width: As required for application.
 2. Thickness: As required for application.
 3. Spacer Rod Diameter: As required for application.
 4. Manufacturers:
 - a. Tremco Global Sealants: www.tremcosealants.com/#sle.
- D. Glazing Splines: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option II; color black.

PART 3 EXECUTION

3.01 VERIFICATION OF CONDITIONS

- A. Verify that openings for glazing are correctly sized and within tolerances, including those for size, squareness, and offsets at corners.
- B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and support framing is ready to receive glazing system.

3.02 PREPARATION

- A. Clean contact surfaces with appropriate solvent and wipe dry within maximum of 24 hours before glazing. Remove coatings that are not tightly bonded to substrates.
- B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
- C. Prime surfaces scheduled to receive sealant where required for proper sealant adhesion.

3.03 INSTALLATION, GENERAL

- A. Install glazing in compliance with written instructions of glass, gaskets, and other glazing material manufacturers, unless more stringent requirements are indicated, including those in glazing referenced standards.

- B. Install glazing sealants in accordance with ASTM C1193, GANA (SM), and manufacturer's instructions.
- C. Do not exceed edge pressures around perimeter of glass lites as stipulated by glass manufacturer.
- D. Set glass lites of system with uniform pattern, draw, bow, and similar characteristics.
- E. Set glass lites in proper orientation so that coatings face exterior or interior as indicated.
- F. Prevent glass from contact with any contaminating substances that may be the result of construction operations such as, and not limited to the following; weld splatter, fire-safing, plastering, mortar droppings, and paint.

3.04 INSTALLATION - DRY GLAZING METHOD (GASKET GLAZING)

- A. Application - Exterior and/or Interior Glazed: Set glazing infills from either the exterior or the interior of the building.
- B. Place setting blocks at 1/4 points with edge block no more than 6 inch from corners.
- C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.
- D. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.05 FIELD QUALITY CONTROL

- A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
- B. Monitor and report installation procedures and unacceptable conditions.

3.06 CLEANING

- A. Remove excess glazing materials from finish surfaces immediately after application using solvents or cleaners recommended by manufacturers.
- B. Remove nonpermanent labels immediately after glazing installation is complete.
- C. Clean glass and adjacent surfaces after sealants are fully cured.
- D. Clean glass on both exposed surfaces not more than 4 days prior to Date of Substantial Completion in accordance with glass manufacturer's written recommendations.

3.07 PROTECTION

- A. After installation, mark pane with an 'X' by using removable plastic tape or paste; do not mark heat absorbing or reflective glass units.
- B. Remove and replace glass that is damaged during construction period prior to Date of Substantial Completion.

END OF SECTION 088000

**SECTION 092116
GYPSUM BOARD ASSEMBLIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal stud wall framing.
- B. Gypsum wallboard.
- C. Joint treatment and accessories.
- D. Textured finish system.

1.02 RELATED REQUIREMENTS

- A. Section 054000 - Cold-Formed Metal Framing: Structural steel stud framing.
- B. Section 092216 - Non-Structural Metal Framing.

1.03 REFERENCE STANDARDS

- A. AISI S100 - North American Specification for the Design of Cold-Formed Steel Structural Members; 2016, with Supplement (2022).
- B. AISI S201 - North American Standard for Cold-Formed Steel Framing - Product Data; 2017.
- C. AISI S220 - North American Standard for Cold-Formed Steel Nonstructural Framing; 2020.
- D. AISI S240 - North American Standard for Cold-Formed Steel Structural Framing; 2020.
- E. ANSI A108.11 - American National Standard Specifications for Interior Installation of Cementitious Backer Units; 2018.
- F. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2025a.
- G. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members; 2025.
- H. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products; 2020.
- I. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board; 2020.
- J. ASTM C1047 - Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base; 2019.
- K. ASTM C1396/C1396M - Standard Specification for Gypsum Board; 2024.
- L. GA-216 - Application and Finishing of Gypsum Panel Products; 2021.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data:
 - 1. Provide data on metal framing, gypsum board, accessories, and joint finishing system.
 - 2. Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.
- C. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

1.05 QUALITY ASSURANCE

- A. Documents at Project Site: Maintain at the project site a copy of manufacturer's instructions, erection drawings, and shop drawings.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

- A. Provide completed assemblies complying with ASTM C840 and GA-216.

2.02 METAL FRAMING MATERIALS

- A. Material and Product Requirements Criteria: AISI S201.
- B. Steel Sheet: ASTM A1003/A1003M, subject to the ductility limitations indicated in AISI S220 or equivalent.
- C. Manufacturers - Metal Framing, Connectors, and Accessories:
 - 1. ClarkDietrich; ____: www.clarkdietrich.com/#sle.
 - 2. Phillips Manufacturing Co; ____: www.phillipsmfg.com/#sle.
 - 3. Substitutions: See Section 016000 - Product Requirements.
- D. Nonstructural Framing System Components: AISI S220; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf.
 - 1. Studs: C-shaped with knurled or embossed faces.
 - 2. Runners: U shaped, sized to match studs.
 - 3. Resilient Furring Channels: Single or double leg configuration; 1/2 inch channel depth.
- E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection and prevent rotation of studs while maintaining structural performance of partition.
 - 1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI S100.
 - 2. Material: ASTM A653/A653M steel sheet, SS Grade 50/340, with G60/Z180 hot-dipped galvanized coating.
 - 3. Provide components UL-listed for use in UL-listed fire-resistance-rated head of partition joint systems indicated on drawings.

2.03 BOARD MATERIALS

- A. Manufacturers - Gypsum-Based Board:
 - 1. American Gypsum Company: www.americangypsum.com/#sle.
 - 2. CertainTeed Corporation: www.certainteed.com/#sle.
 - 3. Georgia-Pacific Gypsum: www.gpgypsum.com/#sle.
 - 4. USG Corporation: www.usg.com/#sle.
- B. Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
 - 1. Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
 - 2. At Assemblies Indicated with Fire-Resistance Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.
 - 3. Thickness:
 - a. Vertical Surfaces: 5/8 inch.
 - b. Ceilings: 5/8 inch.

2.04 GYPSUM BOARD ACCESSORIES

- A. Finishing Accessories: ASTM C1047, extruded aluminum alloy (6063 T5) or galvanized steel sheet ASTM A924/A924M G90, unless noted otherwise.
 - 1. Types: As detailed or required for finished appearance.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that project conditions are appropriate for work of this section to commence.

3.02 SHAFT WALL INSTALLATION

- A. Shaft Wall Framing: Install in accordance with manufacturer's installation instructions.
 - 1. Fasten runners to structure with short leg to finished side, using appropriate power-driven fasteners at not more than 24 inches on center.
 - 2. Install studs at spacing required to meet performance requirements.

- B. Shaft Wall Liner: Cut panels to accurate dimensions and install sequentially between special friction studs.

3.03 FRAMING INSTALLATION

- A. Metal Framing: Install in accordance with ASTM C1007/AISI S220 and manufacturer's instructions.
- B. Studs: Space studs at 16 inches on center.
 - 1. Extend partition framing to structure where indicated and to ceiling in other locations.
 - 2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling track in accordance with manufacturer's instructions.
 - 3. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

3.04 BOARD INSTALLATION

- A. Comply with ASTM C840, GA-216, and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.
- B. Fire-Resistance-Rated Construction: Install gypsum board in strict compliance with requirements of assembly listing.
- C. Cementitious Backing Board: Install over steel framing members and plywood substrate where indicated, in accordance with ANSI A108.11 and manufacturer's instructions.

3.05 INSTALLATION OF TRIM AND ACCESSORIES

- A. Control Joints: Place control joints consistent with lines of building spaces and as indicated.
- B. Corner Beads: Install at external corners, using longest practical lengths.
- C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials.

3.06 JOINT TREATMENT

- A. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
 - 1. Level 5: Walls and ceilings to receive semi-gloss or gloss paint finish and other areas specifically indicated.
 - 2. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
 - 3. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish.
 - 4. Level 1: Fire-resistance-rated wall areas above finished ceilings, whether or not accessible in the completed construction.
- B. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
 - 1. Feather coats of joint compound so that camber is maximum 1/32 inch.
- C. Where Level 5 finish is indicated, spray apply high build drywall surfacer over entire surface after joints have been properly treated; achieve a flat and tool mark-free finish.

3.07 TEXTURE FINISH

- A. Apply finish texture coating by means of spraying apparatus in accordance with manufacturer's instructions and to match approved sample.
- B. Texture Required: Very light orange peel.

END OF SECTION 092116

SECTION 093000 TILING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Tile for floor applications.
- B. Tile for wall applications.
- C. Non-ceramic trim.

1.02 RELATED REQUIREMENTS

- A. Section 092116 - Gypsum Board Assemblies: Tile backer board.
- B. Section 09 30 50- Tile Setting Materials and Accessories

1.03 REFERENCE STANDARDS

- A. ANSI A108/A118/A136 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2019.
- B. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2017.
- C. ANSI A108.1b - Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar; 2023.
- D. ANSI A108.1c - Contractor's Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set, Modified Dry-Set, or Improved Modified Dry-Set Cement Mortar; 2023.
- E. ANSI A108.2 - American National Standard General Requirements: Materials, Environmental and Workmanship; 2019.
- F. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesive or Water Cleanable Tile-Setting Epoxy Adhesive; 2023.
- G. ANSI A108.5 - Setting of Ceramic Tile with Dry-Set Cement Mortar, Modified Dry-Set Cement Mortar, EGP (Exterior Glue Plywood) Modified Dry-Set Cement Mortar, or Improved Modified Dry-Set Cement Mortar; 2023.
- H. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grout Epoxy; 2023.
- I. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (Reaffirmed 2024).
- J. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 2023.
- K. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 2017 (Reaffirmed 2022).
- L. ANSI A108.12 - Installation of Ceramic Tile with EGP (Exterior Glue Plywood) Modified Dry-Set Mortar; 2023.
- M. ANSI A108.13 - American National Standard for Installation of Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone; 2005 (Reaffirmed 2021).
- N. ANSI A108.19 - American National Standard Specifications for Interior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs by the Thin-Bed Method Bonded with Modified Dry-Set Cement Mortar or Improved Modified Dry-Set Cement Mortar; 2020.
- O. ANSI A108.20 - American National Standard Specifications for Exterior Installation of Gauged Porcelain Tiles and Gauged Porcelain Tile Panels/Slabs; 2020.

- P. ANSI A118.6 - American National Standard Specifications for Standard Cement Grouts for Tile Installation; 2019.
- Q. ANSI A118.12 - American National Standard Specifications for Crack Isolation Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 2014 (Reaffirmed 2019).
- R. ANSI A136.1 - American National Standard Specifications for Organic Adhesives for Installation of Ceramic Tile; 2020.
- S. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 2022.
- T. ANSI A137.3 - American National Standard Specification for Gauged Porcelain Tile and Gauged Porcelain Tile Panels/Slabs; 2022 .
- U. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- V. ASTM C150/C150M - Standard Specification for Portland Cement; 2024.
- W. ASTM C373 - Standard Test Methods for Determination of Water Absorption and Associated Properties by Vacuum Method for Pressed Ceramic Tiles and Glass Tiles and Boil Method for Extruded Ceramic Tiles and Non-tile Fired Ceramic Whiteware Products; 2018.
- X. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- Y. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2022.
- Z. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- AA. TCNA (HB) - Handbook for Ceramic, Glass, and Stone Tile Installation; 2022.

1.04 ADMINISTRATIVE REQUIREMENTS

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

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
- C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
- D. Samples: submit full size tile sample for each type and composition of tile and for each color, finish and texture required.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods.
- G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Tile: 5 percent of each size, color, and surface finish combination.

1.06 QUALITY ASSURANCE

- A. Maintain one copy of and ANSI A108/A118/A136 and TCNA (HB) on site.
- B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

- A. Do not install solvent-based products in an unventilated environment.
- B. Maintain ambient and substrate temperature above 50 degrees F and below 100 degrees F during installation and curing of setting materials.

PART 2 PRODUCTS

2.01 TILE

- A. Manufacturers:
 - 1. See drawings for product data
 - 2. Approved equal

2.02 TRIM AND ACCESSORIES

- A. Non-Ceramic Trim: Satin brass anodized extruded aluminum, style and dimensions to suit application, for setting using tile mortar or adhesive.
 - 1. Applications:
 - a. Wall corners, outside and inside.
 - b. Transition between floor finishes of different heights.
 - c. Borders and other trim as indicated on drawings.
 - 2. Manufacturers:
 - a. Schluter-Systems: www.schluter.com/#sle.
 - b. Approved equal

2.03 SETTING/CRACK SUPPRESSION MATERIALS

- A. Manufacturers:
 - 1. Schluter Systems LP
- B. Crack prevention membrane
 - 1. RedGard Crack Prevention Membrane- One coat below all areas to receive tile.
 - 2. Tile Contractor to install expansion joints where needed according to Tile Council recommendations. Provide shop drawings prior to install to show expansion joint locations.
- C. Schluter ALL set Modified Thin set mortar. Color: White
 - 1. Substitutions: See Section 016000 - Product Requirements.

2.04 GROUTS

- A. Manufacturers:
 - 1. Custom Building Products: www.custombuildingproducts.com/#sle.
 - 2. Mapei
- B. Standard Grout: ANSI A118.6 standard cement grout.
 - 1. Applications: Use this type of grout where indicated and where no other type of grout is indicated.
 - 2. Use sanded grout for joints 1/8 inch wide and larger; use unsanded grout for joints less than 1/8 inch wide.

2.05 ACCESSORY MATERIALS

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

3.02 INSTALLATION - GENERAL

- A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1a through ANSI A108.20, manufacturer's instructions, and TCNA (HB) recommendations.

- B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
- C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
- D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
- E. Form internal angles square and external angles bullnosed.
- F. Install non-ceramic trim in accordance with manufacturer's instructions.
- G. Sound tile after setting. Replace hollow sounding units.
- H. Keep control and expansion joints free of mortar, grout, and adhesive.
- I. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
- J. Grout tile joints unless otherwise indicated. Use standard grout unless otherwise indicated.
- K. At changes in plane and tile-to-tile control joints, use schluter DILEX instead of grout, with either bond breaker tape or backer rod as appropriate to prevent three-sided bonding.

END OF SECTION 093000

SECTION 095100 ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Suspended metal grid ceiling system.
- B. Acoustical units.

1.02 REFERENCE STANDARDS

- A. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2021a.
- B. ASTM C635/C635M - Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2022.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- D. ASTM E1264 - Standard Classification for Acoustical Ceiling Products; 2022.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
- B. Do not install acoustical units until after interior wet work is dry.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on suspension system components and acoustical units.
- C. Samples: Submit two samples illustrating material and finish of acoustical units.

1.05 FIELD CONDITIONS

- A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acoustic Tiles/Panels:
 - 1. Armstrong World Industries, Inc: www.armstrongceilings.com/#sle.
 - 2. CertainTeed Corporation: www.certainteed.com/ceilings-and-walls/#sle.
 - 3. Rockfon: www.rockfon.com/#sle.
 - 4. USG Corporation: www.usg.com/ceilings/#sle.
 - 5. Substitutions: See Section 016000 - Product Requirements.
- B. Suspension Systems:
 - 1. Same as for acoustical units.

2.02 ACOUSTICAL UNITS

- A. Acoustical Units - General: ASTM E1264, Class A.
- B. Acoustical Panels See Drawings for product
 - 1. Classification: ASTM E1264 Type III.
 - 2. Size: 24 by 24 inches.
 - 3. Thickness: 3/4 inch.
 - 4. Panel Edge: Square.
 - 5. Color: White.
 - 6. Suspension System: Exposed grid.

- C. Seamless Acoustical Ceilings, Type as indicated on drawings
 - 1. Classification: ASTM E1264 Type XII.
 - 2. Size and Configuration: As indicated on drawings.
 - 3. Thickness: 7/8 inch.
 - 4. Light Reflectance: .87, determined in accordance with ASTM E1264.
 - 5. NRC: .80, determined in accordance with ASTM E1264.
 - 6. Ceiling Attenuation Class (CAC): 46, determined in accordance with ASTM E1264.
 - 7. Panel Edge: Tapered.
 - 8. Color: White.

2.03 SUSPENSION SYSTEM(S)

- A. Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with perimeter moldings, hold down clips, stabilizer bars, clips, and splices as required.
 - 1. Materials:
 - a. Aluminum Grid: Aluminum sheet, ASTM B209/B209M.
- B. Exposed Suspension System, Type ____: Hot-dipped galvanized steel grid with steel cap.
 - 1. Structural Classification: Intermediate-duty, when tested in accordance with ASTM C635/C635M.
 - 2. Profile: Tee; 15/16 inch face width.
 - 3. Products:
 - a. CertainTeed Corporation; 15/16" EZ Stab Classic System: www.certainteed.com/ceilings-and-walls/#sle.
 - b. USG Corporation; Donn Brand ZXLA 15/16 inch Acoustical Suspension System: www.usg.com/ceilings/#sle.
 - c. Armstrong Prelude 15/16"
 - d. Rockfon Equivelant
- C. Enclosure for Recessed Ceiling Fixtures: Mineral fiber insulation box enclosure with foil facing on exterior side for placement over recessed ceiling light fixture; flame spread index of 25 and smoke development index of 0 (zero) when tested in accordance with ASTM E84.
 - 1. Light Fixture Size: As indicated on drawings.

2.04 ACCESSORIES

- A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.
- B. Hanger Wire: 12 gauge, 0.08 inch galvanized steel wire.
- C. Perimeter Moldings: Same metal and finish as grid.

PART 3 EXECUTION

3.01 PREPARATION

- A. Install after major above-ceiling work is complete.
- B. Coordinate the location of hangers with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

- A. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.
- B. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
 - 1. Use longest practical lengths.
- C. Suspension System, Non-Seismic: Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

- D. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
- E. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
- F. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
- G. Do not eccentrically load system or induce rotation of runners.

3.03 INSTALLATION - ACOUSTICAL UNITS

- A. Install acoustical units in accordance with manufacturer's instructions.
- B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
- C. Fit border trim neatly against abutting surfaces.
- D. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
- E. Cutting Acoustical Units:
 - 1. Make field cut edges of same profile as factory edges.
- F. Lay acoustical insulation for a distance of 48 inches either side of acoustical partitions as indicated.

3.04 TOLERANCES

- A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
- B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 CLEANING

- A. Clean surfaces.
- B. Replace damaged or abraded components.

END OF SECTION 095100

SECTION 096500 RESILIENT FLOORING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Resilient sheet flooring.
- B. Resilient base.

1.02 RELATED REQUIREMENTS

- A. Section 033000 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied resilient flooring.
- B. Section 260526 - Grounding and Bonding for Electrical Systems: Grounding and bonding of static control flooring to building grounding system.

1.03 REFERENCE STANDARDS

- A. ASTM F1859 - Standard Specification for Rubber Sheet Floor Covering Without Backing; 2021a.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
- C. Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
- D. Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
- B. Store all materials off of the floor in an acclimatized, weather-tight space.
- C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
- D. Protect roll materials from damage by storing on end.

1.07 FIELD CONDITIONS

- A. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS

2.01 SHEET FLOORING

- A. Rubber Sheet Flooring: see drawings for product info
 - 1. Minimum Requirements: Comply with ASTM F1859, Type 1, without backing.
 - 2. Thickness: 0.125 inch minimum.
- B. Welding Rod: Solid bead in material compatible with flooring, produced by flooring manufacturer for heat welding seams, and in color matching field color.

2.02 RESILIENT BASE

- A. Resilient Base: See drawings for product info

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
- B. Cementitious Subfloor Surfaces: Verify that substrates are ready for resilient flooring installation by testing for moisture and alkalinity (pH).
 - 1. Obtain instructions if test results are not within limits recommended by resilient flooring manufacturer and adhesive materials manufacturer.
- C. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with subfloor filler to achieve smooth, flat, hard surface.
- C. Prohibit traffic until filler is fully cured.
- D. Clean substrate.

3.03 INSTALLATION - GENERAL

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install in accordance with manufacturer's written instructions.
- C. Adhesive-Applied Installation:
 - 1. Spread only enough adhesive to permit installation of materials before initial set.
 - 2. Place copper grounding strip in conductive adhesive and apply additional adhesive to top side of strip before installing static control flooring. Allow strip to extend beyond flooring in accordance with static control flooring manufacturer's instructions. Refer to Section 260526 for grounding and bonding to building grounding system.
 - 3. Fit joints and butt seams tightly.
 - 4. Set flooring in place, press with heavy roller to attain full adhesion.
- D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.

3.04 INSTALLATION - SHEET FLOORING

- A. Lay flooring with joints and seams parallel to longer room dimensions, to produce minimum number of seams. Lay out seams to avoid widths less than 1/3 of roll width; match patterns at seams.
- B. Seal seams by heat welding where indicated.

3.05 INSTALLATION - TILE FLOORING

- A. Mix tile from container to ensure shade variations are consistent when tile is placed, unless otherwise indicated in manufacturer's installation instructions.
- B. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.

3.06 INSTALLATION - RESILIENT BASE

- A. Fit joints tightly and make vertical. Maintain minimum dimension of 18 inches between joints.
- B. Install base on solid backing. Bond tightly to wall and floor surfaces.

3.07 CLEANING

- A. Remove excess adhesive from floor, base, and wall surfaces without damage.
- B. Clean in accordance with manufacturer's written instructions.

3.08 PROTECTION

- A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION 096500

SECTION 096813 TILE CARPETING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Carpet tile, fully adhered.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. ASTM D2859 - Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials; 2016 (Reapproved 2021).
- B. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring; 2022.
- C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride; 2022.
- D. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes; 2019a.
- E. CRI 104 - Standard for Installation of Commercial Carpet; 2015.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
- C. Samples: Submit 1 carpet tile illustrating color and pattern design for each carpet color selected.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and _____.
- E. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 016000 - Product Requirements, for additional provisions.
 - 2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.05 FIELD CONDITIONS

- A. Store materials in area of installation for minimum period of 24 hours prior to installation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Tile Carpeting: See drawings for product info
 - 1. Substitutions: See Section 016000 - Product Requirements.

2.02 MATERIALS

- A. Tile Carpeting, Type ____: Tufted, manufactured in one color dye lot.

2.03 ACCESSORIES

- A. Transitions and nosings as shown on drawings

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
- B. Verify that subfloor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to subfloor surfaces.

- C. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

- A. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
- B. Remove subfloor ridges and bumps. Fill minor or local low spots, cracks, joints, holes, and other defects with subfloor filler.
- C. Vacuum clean substrate.

3.03 INSTALLATION

- A. Starting installation constitutes acceptance of subfloor conditions.
- B. Install carpet tile in accordance with manufacturer's instructions.
- C. Blend carpet from different cartons to ensure minimal variation in color match.
- D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
- E. Lay carpet tile in _____ pattern, with pile direction parallel to next unit, set parallel to building lines.
- F. Trim carpet tile neatly at walls and around interruptions.
- G. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

- A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
- B. Clean and vacuum carpet surfaces.

END OF SECTION 096813

**SECTION 099000
PAINTING AND COATING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Surface preparation.
- B. Interior painting and coating systems.
- C. Exterior painting and coating systems.
- D. Scope:
 - 1. Finish surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
 - a. Exterior:
 - 1) Concrete: Cementitious siding, Flexboard, Transite, non-roof shingles, common brick, stucco, tilt-up, precast, and poured-in-place cement.
 - 2) Masonry: Concrete masonry units (CMU), cinder or concrete block.
 - 3) Metal: Aluminum, galvanized.
 - 4) Metal, Miscellaneous: Iron, ornamental iron, structural iron and steel, ferrous metal.
 - 5) Architectural PVC, plastic, and fiberglass.
 - b. Interior:
 - 1) Concrete, Walls and Ceilings: Poured concrete, precast concrete, unglazed brick, cement board, tilt-up, cast-in-place concrete, and plaster.
 - 2) Metal: Aluminum and galvanized.
 - 3) Metal, Galvanized: Ceilings and ductwork.
 - 4) Metal: Structural steel columns, joists, trusses, beams, miscellaneous and ornamental iron, structural iron, and ferrous metal.
 - 5) Wood: Walls, ceilings, doors, and trim.
 - 6) Drywall: Walls, ceilings, gypsum board, and similar items.

1.02 REFERENCE STANDARDS

- A. SCAQMD 1113 - Architectural Coatings; 1977, with Amendment (2016).
- B. SSPC-SP 1 - Solvent Cleaning; 2015, with Editorial Revision (2016).
- C. SSPC-SP 2 - Hand Tool Cleaning; 2024.
- D. SSPC-SP 3 - Power Tool Cleaning; 2024.
- E. SSPC-SP 6 - Commercial Blast Cleaning; 2007.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide complete list of products to be used, with the following information for each:
 - 1. Product characteristics.
 - 2. Surface preparation instructions and recommendations.
 - 3. Primer requirements and finish specification.
 - 4. Storage and handling requirements and recommendations.
 - 5. Application methods.
 - 6. Clean-up information.
- C. Maintenance Data: Submit coating maintenance manual including finish schedule showing where each product/color/finish was used, product technical data sheets, safety data sheets (SDS), care and cleaning instructions, touch-up procedures, repair of painted and finished surfaces, and color samples of each color and finish used.
- D. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. See Section 016000 - Product Requirements for additional provisions.
2. Extra Paint and Finish Materials: 1 gallon of each color; from the same product run, store where directed.
3. Label each container with color in addition to manufacturer's label.

1.04 MOCK-UPS

- A. See Section 014000 - Quality Requirements for general requirements for mock-ups.
- B. Provide one accent wall as directed by Architect to demonstrate color and finish.
- C. Locate where directed by Architect.
- D. Mock-up may remain as part of the work.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
- B. Container Label: Include manufacturer's name, type of paint, product name, product code, color designation, VOC content, batch date, environmental handling, surface preparation, application, and use instructions.
- C. Paint Materials: Store at a minimum of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer's instructions.
- D. Handling: Maintain a clean, dry storage area to prevent contamination or damage to materials.

1.06 FIELD CONDITIONS

- A. Do not apply materials when environmental conditions are outside the ranges required by manufacturer.
- B. Follow manufacturer's recommended procedures for producing the best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design Products: Subject to compliance with requirements, provide Sherwin-Williams Company (The) products indicated; www.sherwin-williams.com/#sle.

2.02 PAINTINGS AND COATINGS

- A. General:
 1. Provide factory-mixed coatings unless otherwise indicated.
 2. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application.
 3. Do not reduce, thin, or dilute coatings or add materials to coatings unless specifically indicated in manufacturer's instructions.
- B. Accessory Materials: Provide primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials as required for final completion of painted surfaces.

2.03 PAINT SYSTEMS - EXTERIOR

- A. Masonry: Concrete masonry units (CMU), cinder or concrete block.
 1. Latex Systems:
 - a. Satin Finish:
 - 1) 1st Coat: Sherwin-Williams PrepRite Block Filler, B25W25: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams A-100 Exterior Latex Satin, A82 Series: www.sherwin-williams.com/#sle.
- B. Metal: Aluminum, galvanized.
 1. Latex Systems:
 - a. Satin Finish:

- 1) 1st and 2nd Coats: Sherwin-Williams Pro Industrial Acrylic Eg-Shel, B66-660 Series: www.sherwin-williams.com/#sle.
2. Alkyd Systems, Water Based:
 - a. Low Sheen Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Low Sheen, B53-1250 Series: www.sherwin-williams.com/#sle.
- C. Metal, Miscellaneous: Iron, ornamental iron, structural iron and steel, ferrous metal.
 1. Alkyd Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series: www.sherwin-williams.com/#sle.
- D. Architectural PVC, plastic, and fiberglass.
 1. Latex Systems:
 - a. Satin Finish:
 - 1) 1st Coat: Sherwin-Williams Extreme Bond Bonding Primer, B51W00150: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams A-100 Exterior Latex Satin, A82 Series: www.sherwin-williams.com/#sle.

2.04 PAINT SYSTEMS - INTERIOR

- A. Metal: Aluminum and galvanized.
 1. Alkyd Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series: www.sherwin-williams.com/#sle.
 - b. Low Sheen Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Low Sheen, B53-1250 Series: www.sherwin-williams.com/#sle.
- B. Metal: Structural steel columns, joists, trusses, beams, miscellaneous and ornamental iron, structural iron, and ferrous metal.
 1. Alkyd Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Pro Industrial Pro-Cryl Universal Primer, B66-1310 Series: www.sherwin-williams.com/#sle.
(a) 5 mils wet, 2 mils dry per coat.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Water Based Alkyd Urethane Enamel Semi-Gloss, B53-1150 Series: www.sherwin-williams.com/#sle.
(a) 4 to 5 mils wet, 1.4 to 1.7 mils dry per coat.
- C. Wood: Walls, ceilings, doors, and trim.
 1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams Premium Wall and Wood Primer, B28W8111: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProClassic Waterborne Acrylic Semi-Gloss, B31 Series: www.sherwin-williams.com/#sle.

- D. Drywall: Walls, ceilings, gypsum board, and similar items.
1. Latex Systems:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Latex Semi-Gloss, B31-2600 Series: www.sherwin-williams.com/#sle.
 - b. Eg-Shel Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Eg-Shel, B20-2600 Series: www.sherwin-williams.com/#sle.
 - c. Low Sheen Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Latex Low Gloss Eg-Shel, B41-1950 Series: www.sherwin-williams.com/#sle.
 - d. Flat Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams ProMar 200 Zero VOC Latex Flat, B30-2600 Series: www.sherwin-williams.com/#sle.
 2. Epoxy Systems, Water Based:
 - a. Semi-Gloss Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K46 Series: www.sherwin-williams.com/#sle.
 - b. Eg-Shel/Low Luster Finish:
 - 1) 1st Coat: Sherwin-Williams ProMar 200 Zero VOC Interior Latex Primer, B28W2600: www.sherwin-williams.com/#sle.
 - 2) 2nd and 3rd Coat: Sherwin-Williams Pro Industrial Pre-Catalyzed Waterbased Epoxy, K45 Series: www.sherwin-williams.com/#sle.

PART 3 EXECUTION

3.01 PREPARATION

- A. Clean surfaces thoroughly and correct defects prior to application.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
- C. Aluminum: Remove surface contamination and oil; wash with solvent according to SSPC-SP 1.
- D. Galvanized Surfaces:
 1. Remove surface contamination and oils and wash with solvent according to SSPC-SP 1.
 2. Prepare surface according to SSPC-SP 2.
- E. Ferrous Metal:
 1. Solvent clean according to SSPC-SP 1.
 2. Shop-Primed Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Prime bare steel surfaces.
 3. Remove rust, loose mill scale, and other foreign substances using methods recommended by paint manufacturer and blast cleaning according to SSPC-SP 6. Protect from corrosion until coated.
- F. Wood: Remove dust, grit, and foreign matter. Scrape, sand, and spot prime knots and pitch streaks. Fill nail holes and imperfections with wood filler and sand smooth.

3.02 APPLICATION

- A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
- B. Apply products in accordance with manufacturer's written instructions.
- C. Apply coatings at spread rate required to achieve manufacturer's recommended dry film thickness.
- D. Regardless of number of coats specified, apply additional coats until complete hide is achieved.

3.03 PRIMING

- A. Apply primer to all surfaces unless specifically not required by coating manufacturer. Apply in accordance with coating manufacturer's instructions.
- B. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to top coat manufacturers.

3.04 CLEANING

- A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.
- B. Clean surfaces immediately of overspray, splatter, and excess material.
- C. After coating has cured, clean and replace finish hardware, fixtures, and fittings previously removed.

3.05 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged finishes after Substantial Completion.

END OF SECTION 099000

SECTION 102113.17
PHENOLIC TOILET COMPARTMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Phenolic toilet compartments.
- B. Phenolic urinal screens.

1.02 RELATED REQUIREMENTS

- A. Section 055000 - Metal Fabrications: Concealed steel support members.
- B. Section 102800 - Toilet Accessories.

1.03 REFERENCE STANDARDS

- A. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- B. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- C. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- D. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate work with placement of support framing and anchors in walls and ceilings.

1.05 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on panel construction, hardware, accessories, and finishes.
- C. Shop Drawings:
 - 1. Indicate plans, elevations, and dimensions. Include door swings, toilet fixture centerlines, and floor drains on plans.
- D. Samples:
 - 1. For Initial Selection: Submit color charts and samples for each type of toilet compartment material.
- E. Manufacturer's qualification statement.

1.06 QUALITY ASSURANCE

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

1.07 DELIVERY, STORAGE, AND HANDLING

- A. See Section 017419 - Construction Waste Management and Disposal for packaging waste requirements.

1.08 FIELD CONDITIONS

- A. Ambient Conditions: Maintain environmental conditions such as temperature, humidity, and ventilation within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. ASI Global Partitions: www.asi-globalpartitions.com/#sle.
- B. Substitutions: See Section 016000 - Product Requirements.

2.02 PHENOLIC TOILET COMPARTMENTS

- A. Toilet Compartments: Color-Thru phenolic.
 - 1. Ultimate Privacy-58; floor-anchored, overhead-braced mounting.
- B. Fabrication:
 - 1. Fabricate toilet compartment components to sizes indicated.
 - 2. Coordinate requirements and provide cutouts for through-partition toilet accessories and solid blocking within panel where required for attachment of toilet accessories.
 - 3. Provide shoes and caps at pilasters and posts to conceal anchorage, supports, and leveling mechanisms.
 - 4. Provide manufacturer's standard corrosion-resistant supports, leveling mechanisms, anchors, and anchoring assemblies for pilasters and posts.
 - 5. Floor-Anchored, Overhead-Braced Units: Provide supports, leveling mechanisms, Easy-Stall shoes, and anchors at pilasters to suit floor conditions.

2.03 COMPONENTS

- A. Doors, Panels, and Pilasters: Phenolic-resin impregnated, wood-based product core with melamine-impregnated decorative surface papers and transparent, protective topcoat; NEMA LD 3 Compact Laminate.
 - 1. Finish: Matte.
 - 2. Color-Thru Phenolic Color: As selected from manufacturer's color card.
 - 3. Privacy: Provide interlocking doors and pilasters with integral Zero-Sightline System routed edges.
- B. Standard Door and Panel Dimensions:
 - 1. Door Thickness: 3/4 inch.
 - 2. Door Width: 24 inches.
 - 3. Door Width for Handicapped Use: 36 inches, outswinging.
- C. Standard Pilasters: 3/4 inch thick, of sizes required to suit compartment width and spacing.
 - 1. Pilaster Height: 82 inches.
- D. Urinal or Entrance Screen Post: Manufacturer's standard post design of square aluminum tube with satin finish 1-3/4 inches, with shoe matching pilaster shoe.

2.04 MATERIALS

- A. Aluminum Extrusions: ASTM B221 (ASTM B221M).
- B. Phenolic Panels: Monolithic core of phenolic resin, reinforced with cellulose fibers, manufactured under high pressure and at high temperatures, with melamine-impregnated decorative surface papers; NEMA LD 3, Compact Laminate.

2.05 HARDWARE AND ACCESSORIES

- A. Brackets:
 - 1. Continuous Type: Brushed aluminum, standard depth.
- B. Standard Door Hardware: Brushed chrome-plated zamac.
 - 1. Hinges: Brushed chrome-plated zamac Alpaco and Ultimate Privacy barrel hinges.
 - 2. Latch and Keeper: Brushed chrome-plated zamac surface mount slide latch.
 - 3. Coat Hook: Manufacturer's standard coat hook with rubber bumper; one per compartment, mounted on door.
- C. Standard Door Hardware: Aluminum.
 - 1. Hinges: Brushed aluminum.
 - 2. Latch and Keeper: Brushed aluminum with integral occupancy indicator.
 - 3. Coat Hook: Manufacturer's standard coat hook with rubber bumper; one per compartment, mounted on door.
 - 4. Door Pull: Provide door pull for outswinging doors. Provide on both sides of doors designated as accessible.

- 5. Door Bumper: Provide rubber-tipped door bumpers at out-swinging doors.
- D. Attachments, Screws, and Bolts: Stainless steel, tamper-resistant type.
 - 1. For Attaching Panels and Pilasters to Brackets: Sex-type through-bolts and nuts, tamper-resistant.
- E. Toilet Partition Suspension Members: See Section 055000.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify that field measurements are as indicated.
- C. Verify correct spacing of and between plumbing fixtures.
- D. Verify correct location of built-in framing, anchorage, and bracing.

3.02 INSTALLATION

- A. Install partitions secure, rigid, plumb, and level in accordance with manufacturer's written instructions.
- B. Attach panel brackets securely to walls using anchor devices.
- C. Attach panels and pilasters to brackets. Locate head rail joints at pilaster centerlines.
- D. Field touch-up of scratches or damaged finish not permitted. Replace damaged or scratched materials with new materials.

3.03 TOLERANCES

- A. Maximum Variation from True Position: 1/4 inch.
- B. Maximum Variation from Plumb: 1/8 inch.

3.04 ADJUSTING

- A. Adjust and align hardware to uniform clearance at vertical edge of doors, not exceeding 3/16 inch.
- B. Adjust adjacent components for consistency of line or plane.

3.05 CLEANING

- A. Clean partition and screen surfaces with materials and cleansers in accordance with manufacturer's recommendations.

END OF SECTION 102113.17

SECTION 102239 FOLDING PANEL PARTITIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Top-supported folding panel partitions, horizontal opening.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wood blocking and track support shimming.

1.03 REFERENCE STANDARDS

- A. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2021.
- B. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2021.
- C. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).
- D. ASTM E413 - Classification for Rating Sound Insulation; 2022.
- E. ASTM E557 - Standard Guide for Architectural Design and Installation Practices for Sound Isolation Between Spaces Separated by Operable Partitions; 2012 (Reapproved 2026).
- F. ASTM F793/F793M - Standard Classification of Wall Coverings and Ceiling Coverings by Use Characteristics; 2025.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on partition materials, operation, hardware and accessories, and colors and finishes available.
- C. Shop Drawings: Indicate opening sizes, track layout, details of track and required supports, static and dynamic loads, adjacent construction and finish trim, and stacking depth.
- D. Samples for Selection: Submit two samples of full manufacturer's color range for selection of colors.
- E. Samples for Review: Submit two samples of surface finish, 12 by 12 inches size, illustrating quality, colors selected, texture, and weight.
- F. Certificates: Certify that partition system meets or exceeds specified acoustic requirements.
- G. Maintenance Data: Include recommended cleaning methods, cleaning materials, and stain removal methods. Describe cleaning materials detrimental to finish surfaces and hardware finish.

1.05 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Folding Panel Partitions - Horizontal Opening:
 - 1. Kwik-Wall Company; 3000 Series Operable Walls: www.kwik-wall.com/#sle.
 - 2. Substitutions: See Section 016000 - Product Requirements.

2.02 FOLDING PANEL PARTITIONS - HORIZONTAL OPENING

- A. Folding Panel Partitions: Side opening; paired panels; side stacking; manually operated.
- B. Panel Construction:
 - 1. Frame: 16 gauge, 0.0598 inch thick formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, with acoustical insulation fill.

2. Panel Substrate Facing: Steel sheet, manufacturer's standard thickness.
3. Hinges: concealed
4. Panel Properties:
 - a. Thickness With Finish: 4 inches.
 - b. Width: Equal widths.
 - c. Weight: 10 lb/sq ft.
- C. Panel Finishes:
 1. Facing: Vinyl coated fabric to be selected by architect from manufacturer's full line.
- D. Panel Seals:
 1. Panel to Panel Seals: Grooved and gasketed astragals, with continuous flexible ribbed vinyl seal fitted to panel edge construction; color to match panel finish.
 2. Acoustic Seals: Flexible acoustic seals at jambs, meeting mullions, ceilings, retractable floor and ceiling seals, and above track to structure acoustic seal.
- E. Suspension System:
 1. Track: Extruded aluminum; 1-1/4 by 1-1/4 inch size; thickness and profile designed to support loads, steel sub-channel and track connectors, and track switches.
 2. Carriers: Steel, ball bearing wheels on trolley carrier at top of every second panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.
- F. Performance:
 1. Acoustic Performance:
 - a. Sound Transmission Class (STC): 52 calculated in accordance with ASTM E413, based on tests conducted in accordance with ASTM E90, on panel size of 100 sq ft.
 2. Installed partition system track capable of supporting imposed loads, with maximum deflection of 1/360 of span.
- G. Accessories:
 1. Ceiling Closure: White enameled ceiling closure; aluminum jamb and head molding, fittings and attachments, and intermediate meeting posts.
 2. Pocket Enclosures: Door, frame, and trim to match adjacent walls.
 3. Acoustic Sealant: As recommended by partition manufacturer.

2.03 MATERIALS

- A. Aluminum Extrusions: ASTM B221 (ASTM B221M), 6063 alloy, T6 temper.
- B. Vinyl Coated Fabric: ASTM F793 Category VI, polyvinyl fluoride (PVC) finish for washability and improved flame retardance; color as selected by architect from manufacturer's full range.
- C. Acoustic Insulation:
 1. Type: As required for acoustic performance indicated.
 2. Thickness: As required for acoustic performance indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify track supports are laterally braced and will permit track to be level within 1/4 inch of required position and parallel to the floor surface.
- C. Verify floor flatness of 1/8 inch in 10 feet, non-cumulative.
- D. Verify wall plumbness of 1/8 inch in 10 feet, non-cumulative.

3.02 INSTALLATION

- A. Install partition in accordance with manufacturer's instructions and ASTM E557.
- B. Lubricate moving components.
- C. Install acoustic sealant to achieve required acoustic performance.

- D. Coordinate electrical connections.

3.03 ADJUSTING

- A. Adjust partition assembly to provide smooth operation from stacked to full open position. Do not over-compress acoustic seals.
- B. Visually inspect partition in full extended position for light leaks to identify a potential acoustical leak.
- C. Adjust partition assembly to achieve lightproof seal.

3.04 CLEANING

- A. Clean finish surfaces and partition accessories.

3.05 CLOSEOUT ACTIVITIES

- A. Demonstrate operation of partition and identify potential operational problems.

END OF SECTION 102239

**SECTION 102600
WALL AND DOOR PROTECTION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Corner guards: refer to plans for location and product specifications.

1.02 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Indicate physical dimensions, features, wall mounting brackets with mounted measurements, anchorage details, and rough-in measurements.
- C. Samples: Submit samples illustrating component design, configurations, joinery, color and finish.

1.03 WARRANTY

- A. See Section 017800 - Closeout Submittals, for additional warranty requirements.
- B. Correct defective Work within a one year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

2.02 PRODUCT TYPES

- A. Corner Guards - Flush Mounted:
 - 1. Material: High impact vinyl with full height extruded aluminum retainer.
 - 2. Width of Wings: 2 inches.
 - 3. Corner: Square.
 - 4. Color: As selected from manufacturer's standard colors.
 - 5. Length: One piece.

2.03 FABRICATION

- A. Fabricate components with tight joints, corners and seams.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that rough openings, concealed blocking, and anchors are correctly sized and located.
- B. Verify that substrate surfaces for adhered items are clean and smooth.

3.02 INSTALLATION

- A. Position corner guard 4 inches above finished floor to ceiling.

3.03 CLEANING

- A. Clean wall and door protection items of excess adhesive, dust, dirt, and other contaminants.

END OF SECTION 102600

SECTION 102800 TOILET ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Commercial toilet accessories.

1.02 REFERENCE STANDARDS

- A. ASTM C1036 - Standard Specification for Flat Glass; 2021.
- B. ASTM C1503 - Standard Specification for Silvered Flat Glass Mirror; 2018.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. As indicated on drawings

2.02 MATERIALS

- A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
- B. No names or labels are permitted on exposed faces of toilet and bath accessory units. On either interior surface not exposed to view or on back surface, provide identification of each accessory item either by a printed waterproof label or a stamped nameplate indicating manufacturer's name and product model number.
- C. Surface-Mounted Toilet Accessories, General: Except where otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel piano hinge. Provide concealed anchorage wherever possible.
- D. Recessed Toilet Accessories, General: Except where otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors or access panels with full-length, stainless steel piano hinge. Provide anchorage that is fully concealed when unit is closed.
- E. Keys: Provide universal keys for access to toilet accessory units requiring internal access for servicing, resupply, etc. Provide minimum of six keys to Owner's representative.
- F. Mirror Glass: Annealed float glass, ASTM C1036 Type I, Class 1, Quality Q2, with silvering, protective and physical characteristics complying with ASTM C1503.

2.03 COMMERCIAL TOILET ACCESSORIES

- A. General: Only a maximum 1-1/2-inch-diameter, unobtrusive stamped manufacturer logo, as approved by Architect, is permitted on exposed face of toilet or bath accessory units. On either interior surface not exposed to view or back surface, provide additional identification by either a printed, waterproof label or a stamped nameplate, indicating manufacturer's name and product model number.
- B. As indicated on drawings.
- C. Mirrors: Stainless steel framed, 1/4 inch thick annealed float glass; ASTM C1036.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify exact location of accessories for installation.

3.02 INSTALLATION

- A. Install accessories in accordance with manufacturers' instructions in locations indicated on drawings.
- B. Install plumb and level, securely and rigidly anchored to substrate.
- C. Install grab bars to withstand a downward load of at least 250 lbf, complying with ASTM F 446.
- D. Secure mirrors to walls in concealed, tamperproof manner with special hangers, toggle bolts, or screws. Set units plumb, level, and square at locations indicated, according to manufacturer's instructions for type of substrate involved.
- E. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.
 - 1. Grab Bars: As indicated on drawings.
 - 2. Other Accessories: As indicated on drawings.

3.03 PROTECTION

- A. Protect installed accessories from damage due to subsequent construction operations.
- B. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly. Replace damaged or defective items.
- C. Clean and polish all exposed surfaces strictly according to manufacturer's recommendations after removing temporary labels and protective coatings.

END OF SECTION 102800

**SECTION 104400
FIRE PROTECTION SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Fire extinguishers.
- B. Fire extinguisher cabinets.
- C. Accessories.

1.02 RELATED REQUIREMENTS

- A. Section 061000 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems; 2013a (Reapproved 2017).
- B. FM (AG) - FM Approval Guide; Current Edition.
- C. NFPA 10 - Standard for Portable Fire Extinguishers; 2026.
- D. UL (DIR) - Online Certifications Directory; Current Edition.

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide extinguisher operational features.
- C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
- D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
- E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- F. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.05 FIELD CONDITIONS

- A. Do not install extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Fire Extinguishers:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Cosmic Extinguisher - Multipurpose Chemical: www.activarcpg.com/#sle.
 - 2. Larsens Mfg. Co - Model MP-10.
- B. Fire Extinguisher Cabinets and Accessories:
 - 1. Activar Construction Products Group, Inc. - JL Industries; Ambassador Series: www.activarcpg.com/#sle.
 - 2. Larsen's Manufacturing Co; Architectural Series, Vertical Duo: www.larsensmfg.com/#sle.

2.02 FIRE EXTINGUISHERS

- A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
 - 1. Provide extinguishers labeled by UL (DIR) or FM (AG) for purpose specified and as indicated.
- B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
 - 1. Class: A:B:C type.
 - 2. Size: 10 pound.

3. Temperature range: Minus 40 degrees F to 120 degrees F.

2.03 FIRE EXTINGUISHER CABINETS

- A. Fire Rating: Listed and labeled in accordance with ASTM E814 requirements for fire resistance rating of walls where being installed.
- B. Cabinet Construction: Non-fire rated.
 1. Formed primed steel sheet; 0.036 inch thick base metal.
- C. Cabinet Configuration: Semi-Recessed
 1. Size to accommodate accessories.
 2. Trim: Flat square edge, with 1-1/4" inch wide face.
 3. Provide cabinet enclosure with right angle inside corners and seams, and with formed perimeter trim and door stiles.
- D. Door: 0.036 inch metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinges.
- E. Door Glazing: Float glass, clear, 1/8 inch thick, and set in resilient channel glazing gasket.
- F. Door Handle: Recessed type
- G. Cabinet Mounting Hardware: Appropriate to cabinet, with pre-drilled holes for placement of anchors.
- H. Fabrication: Weld, fill, and grind components smooth.
- I. Finish of Cabinet Exterior Trim and Door: Baked enamel, color as selected.
- J. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES

- A. Extinguisher Brackets: Formed steel, galvanized and enamel finished.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions before starting work.
- B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure rigidly in place.
- C. Place extinguishers in cabinets.

END OF SECTION 104400

**SECTION 113013
RESIDENTIAL APPLIANCES**

PART 1 GENERAL

1.01 SECTION INCLUDES

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

1.02 RELATED REQUIREMENTS

- A. Section 221000 - Plumbing Piping: Plumbing connections for appliances.

1.03 REFERENCE STANDARDS

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

1.04 SUBMITTALS

- A. See Section 013000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's data indicating dimensions, capacity, and operating features of each piece of residential equipment specified.
- C. Copies of Warranties: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

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

PART 2 PRODUCTS

2.01 KITCHEN APPLIANCES

- A. Refer to Drawing **A702 INTERIOR MATERIAL LEGEND**

2.02 LAUNDRY APPLIANCES

- A. Refer to Drawing **A702 INTERIOR MATERIAL LEGEND**

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 113013

SECTION 122400 WINDOW SHADES

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Interior motorized roller shades.
- B. Motor controls.

1.02 REFERENCE STANDARDS

- A. NFPA 701 - Standard Methods of Fire Tests for Flame Propagation of Textiles and Films; 2023, with Errata.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Where motorized shades are to be controlled by control systems provided under other sections, coordinate the work with other trades to provide compatible products.
 - 2. Coordinate the work with other trades to provide rough-in of electrical wiring as required for installation of hardwired motorized shades.
- B. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of affected installers.
- C. Sequencing:
 - 1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
 - 2. Do not install shades until final surface finishes and painting are complete.

1.04 SUBMITTALS

- A. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
 - 1. Motorized Shades: Include power requirements and standard wiring diagrams for specified products.
- B. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.
 - 1. Motorized Shades: Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
- C. Selection Samples: Include fabric samples in full range of available colors and patterns.
 - 1. Motorized Shades: Include finish selections for controls.
- D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- E. Project Record Documents: Record actual locations of control systems and show interconnecting wiring.
- F. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

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

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

1.07 FIELD CONDITIONS

- A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY

- A. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
 - 1. Shade Hardware: One year.
 - 2. Electric Motors: One year.
 - 3. Electronic Control Equipment: One year.
 - 4. Fabric: One year.
 - 5. Aluminum and Steel Coatings: One year.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Interior Motorized Roller Shades, Motors and Motor Controls:
 - 1. Draper, Inc; Motorized FlexShade: www.draperinc.com/#sle.
 - 2. Hunter Douglas Architectural; RB500 Motorized Roller Shades: www.hunterdouglasarchitectural.com/#sle.
 - 3. Inpro Corporation; Bottom-Up and Skylight Shades: www.inprocorp.com/#sle.
 - 4. Lutron Electronics Co., Inc; QS Motorized Roller Shades: www.lutron.com/#sle.
 - 5. MechoShade Systems LLC; UrbanShade Single Roller - Motorized: www.mechoshade.com/#sle.

2.02 ROLLER SHADES

- A. General:
 - 1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
 - 2. Provide shade system that operates smoothly when shades are raised or lowered.
- B. Interior Roller Shades - Basis of Design: Draper, Inc; FlexShade 2: www.draperinc.com/#sle.
 - 1. Description: Single roller, motor-operated fabric window shade system complete with mounting brackets, roller tubes, hembars, hardware, and other components necessary for complete installation.
 - a. Drop Position: Regular roll.
 - b. Roll Direction: Roll down, closed position is at window sill.
 - 2. Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
 - 3. Roller Tubes: As required for type of shade operation; designed for removal without removing mounting hardware.
 - a. Material: Extruded aluminum or steel, with wall thickness and material selected by manufacturer.
 - b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
 - 4. Shade Motor: Standard 120V AC motor, located as indicated on drawings.

2.03 SHADE FABRIC

- A. Fabric for Light-Filtering Shades: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.

2.04 MOTOR CONTROLS

- A. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
- B. Provide all components and connections necessary to interface with other systems as indicated.

2.05 ROLLER SHADE FABRICATION

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.
 - 1. Vertical Dimensions: Fill openings from head to sill with 1/2 inch space between bottom bar and window stool.
 - 2. Horizontal Dimensions - Inside Mounting: Fill openings from jamb to jamb.
 - 3. Horizontal Dimensions - Inside Mounting: Provide symmetrical light gaps on both sides of shade not to exceed 3/4 inch total.
- C. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Examine finished openings for deficiencies that may preclude satisfactory installation.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Start of installation shall be considered acceptance of substrates.

3.02 PREPARATION

- A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- B. Coordinate with window installation and placement of concealed blocking to support shades.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.
- B. Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.

3.04 SYSTEM STARTUP

- A. Motorized Shade System: Provide services of a manufacturer's authorized representative to perform system startup.

3.05 CLEANING

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.

3.06 CLOSEOUT ACTIVITIES

- A. Demonstration: Demonstrate operation and maintenance of window shade system to Owner's personnel.
- B. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours training by manufacturer's authorized personnel at location designated by the Owner.

3.07 PROTECTION

- A. Protect installed products from subsequent construction operations.
- B. Touch-up, repair, or replace damaged products before Substantial Completion.

END OF SECTION 122400

SECTION 123600 COUNTERTOPS

PART 1 GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 064100 - Architectural Wood Casework.
- B. Section 224000 - Plumbing Fixtures: Sinks.

1.02 REFERENCE STANDARDS

- A. ISFA 3-01 - Classification and Standards for Quartz Surfacing Material; 2013.
- B. NEMA LD 3 - High-Pressure Decorative Laminates; 2005.
- C. NSI (DSDM) - Dimensional Stone Design Manual, Version VIII; 2016.
- D. PS 1 - Structural Plywood; 2023.

1.03 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Specimen warranty.
- C. Shop Drawings: Complete details of materials and installation ; combine with shop drawings of cabinets and casework specified in other sections.
- D. Verification Samples: For each finish product specified, minimum size 6 inches square, representing actual product, color, and patterns.
- E. Test Reports: Chemical resistance testing, showing compliance with specified requirements.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing work of the type specified in this section, with not less than three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.06 FIELD CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.01 COUNTERTOPS

- A. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
 - 1. Refer to drawings for product info
 - a. Manufacturers:
 - 1) Substitutions: See Section 016000 - Product Requirements.
 - 2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/4 inch thick; covered with matching laminate.
 - 3. Back and End Splashes: Same material, same construction.
 - 4. Fabricate in accordance with manufacturer's standard requirements.

- B. Natural Quartz and Resin Composite Countertops: Sheet or slab of natural quartz and plastic resin over continuous substrate.
 - 1. Flat Sheet Thickness: 1-1/4 inch, minimum.
 - 2. Natural Quartz and Resin Composite Sheets, Slabs and Castings: Complying with ISFA 3-01 and NEMA LD 3; orthophthalic polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard stone fabrication tools; no surface coating; color and pattern consistent throughout thickness.
 - a. Manufacturers:
 - 1) Refer to drawings
 - 2) Substitutions: See Section 016000 - Product Requirements.
 - b. Factory fabricate components to the greatest extent practical in sizes and shapes indicated; comply with NSI (DSDM).
 - c. Finish on Exposed Surfaces: Polished.
 - 3. Other Components Thickness: 3/4 inch, minimum.
 - 4. Back and End Splashes: as specified on drawings

2.02 MATERIALS

- A. Plywood for Supporting Substrate: PS 1 Exterior Grade, A-C veneer grade, minimum 5-ply; minimum 3/4 inch thick; join lengths using metal splines.
- B. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
- C. Joint Sealant: Mildew-resistant silicone sealant, white.

2.03 FABRICATION

- A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
 - 1. Join lengths of tops using best method recommended by manufacturer.
 - 2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
 - 3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.
- B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
 - 1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
 - 2. Height: 4 inches, unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.

- B. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
- C. Seal joint between back/end splashes and vertical surfaces.

3.04 TOLERANCES

- A. Variation From Horizontal: 1/8 inch in 10 feet, maximum.
- B. Offset From Wall, Countertops: 1/8 inch maximum; 1/16 inch minimum.
- C. Field Joints: 1/8 inch wide, maximum.

3.05 CLEANING

3.06 PROTECTION

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

END OF SECTION 123600

SECTION 142400 HYDRAULIC ELEVATORS

PART 1 GENERAL

1.01 REFERENCE STANDARDS

- A. ASME A17.1 - Safety Code for Elevators and Escalators Includes Requirements for Elevators, Escalators, Dumbwaiters, Moving Walks, Material Lifts, and Dumbwaiters with Automatic Transfer Devices; 2025.
- B. ISO 9001 - Quality Management Systems — Requirements; 2015.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. NFPA 80 - Standard for Fire Doors and Other Opening Protectives; 2025, with Amendment (2024).
- E. UL 10B - Standard for Fire Tests of Door Assemblies; Current Edition, Including All Revisions.

1.02 SUMMARY

- A. This section specifies hydraulic elevators.
- B. Work Required
 - 1. The work required under this section consists of all labor, materials and services required for the complete installation (including operational verification) of all the equipment required for the elevator(s) as herein specified.
 - 2. All work shall be performed in a first class, safe and workmanlike manner.
 - 3. In all cases where a device or part of the equipment is herein referred to in the singular, it is intended that such reference shall apply to as many of such devices or parts as are required to make complete installation.

1.03 RELATED SECTIONS

- A. The following sections contain requirements that relate to this section and are performed by trades other than the elevator manufacturer/installer.
 - 1. Section 01 50 00 – Temporary Facilities and Controls: protection of floor openings and personnel barriers; temporary power and lighting.
 - 2. Section 03 30 00 – Cast-In-Place Concrete: elevator pit, elevator motor and pump foundation, and grouting thresholds.
 - 3. Section 04 20 00 – Unit Masonry: masonry hoistway enclosure, building-in and grouting hoistway doorframes, and grouting of sills.
 - 4. Section 05 50 00 – Metal Fabrications: pit ladder, divider beams, supports for entrances and rails, and hoisting beam at top of elevator hoistway.
 - 5. Section 07 13 00 – Sheet Waterproofing: waterproofing of elevator pit.
 - 6. Section 26 05 00 – Electrical General Provisions:
 - a. Main disconnects for each elevator.
 - b. Electrical power for elevator installation and testing.
 - c. Disconnecting device to elevator equipment prior to activation of sprinkler system.
 - d. The installation of dedicated GFCI receptacles in the pit and overhead.
 - e. Lighting in controller area, machine area and pit.
 - f. Wiring for telephone service to controller.
 - 7. Section 27 32 23 – Voice Communications Elevator Telephones
 - 8. Section 28 31 11 – Addressable Fire Alarm Systems

1.04 REFERENCES

- A. Comply with applicable building and elevator codes at the project site, including but not limited to the following:
 - 1. ASME A17.1/CSA B44, Safety Code for Elevators and Escalators.
 - 2. ASME A17.7/CSA B44, Performance-Based Safety Code for Elevators and Escalators.

3. ADAAG, American Disabilities Act Accessibility Guidelines.
4. ANSI A117.1, Building and Facilities, Providing Accessibility and Usability for Physically Handicapped People.
5. ANSI/NFPA 70, (NEC) National Electrical Code.
6. CAN/CSA C22.1, (CEC) Canadian Electrical Code.
7. ANSI/UL 10B, Standard for Fire Test of Door Assemblies.
8. CAN/ULC-S104-10, Standard Method for Fire Test of Door Assemblies.
9. ANSI/NFPA 80, Standard for Fire Doors and Other Opening Protectives.
10. Building Codes IBC or NBCC.
11. All Local Jurisdictional applicable codes.

1.05 SYSTEM DESCRIPTION

- A. Equipment Description: Hole-less Hydraulic elevator with Machine-Room-Less application
- B. Equipment Control: Elevonic® Control System.
- C. Quantity of Elevators: 1
- D. Elevator Stop Designations: 2
- E. Stops: 2
- F. Openings:
 1. In-Line
- G. Travel: 17'-0"
- H. Rated Capacity:
 1. 4500 lb.
- I. Rated Speed:
 1. 100 fpm
- J. Platform Size:
 1. 4500H Front (5'-6 ¾" W x 8'-8" D)
- K. Clear Inside Dimensions:
 1. 4500 Front (5'-5 9/16" W x 7'-10 15/16" D)
- L. Cab Height:
 1. 7'-9"
- M. Clear Cab Height:
 1. 7'-9" with 5/16" Floor Recess and 4 LED Ceiling
- N. Entrance Type and Width:
 1. 4500 (Two Speed Doors – 48" [47.99] inch
- O. Entrance Height: (Select)
 1. 7'-0" [84.02] inch
- P. Main Power Supply: three-phase, 60 Hz □ 5% of normal, with a separate equipment grounding conductor.
- Q. Car Lighting Power Supply: 120 volts, single-phase, 15 amps, 60 Hz.
- R. Machine Location: No machine-room required, tank and controller in hoistway pit.
- S. Signal Fixtures: Manufacturer's standard with stainless steel metal button targets (excluding CA).
- T. Controller Location: Inside hoistway, accessible by a door in a side hoistway wall on the 1st or 2nd landing. (1st landing only if rear entrance)
- U. Stopping Accuracy: 1/4" 0.25 inch under any loading condition or direction of travel.
- V. Operation:

1. Simplex Collective Operation: Using a microprocessor-based controller, operation shall be automatic by means of the car and hall buttons. If all calls in the system have been answered, the car shall park at the last landing served.
- W. Door Control Features:
1. Door control to open doors automatically when car arrives at a landing in response to a normal hall or car call.
 2. Elevator doors shall be provided with a reopening device that will stop and reopen the car door(s) and hoistway door(s) automatically should the door(s) become obstructed by an object or person.
 3. Door protection shall consist of a two dimensional, multi-beam array projecting across the car door opening.
 4. Door nudging operation to occur if doors are prevented from closing for an adjustable period of time.

1.06 SUBMITTALS

- A. Product Data: Submit manufacturer's product data for each system proposed for use. Include the following:
1. Signal and operating fixtures, operating panels and indicators.
 2. Cab design, dimensions and layout.
 3. Hoistway-door and frame details.
 4. Electrical characteristics and connection requirements.
 5. Expected heat dissipation of elevator equipment in hoistway (BTU).
 6. Color selection chart for Cab and Entrances.
- B. Shop Drawings: Submit approval layout drawings. Include the following:
1. Car, guide rails, buffers, and other components in hoistway.
 2. Maximum rail bracket spacing.
 3. Maximum loads imposed on guide rails requiring load transfer to building structure.
 4. Clearances and travel of car.
 5. Clear inside hoistway and pit dimensions.
 6. Location and sizes of access doors, hoistway entrances and frames.
- C. Operations and Maintenance Manuals: Provide manufacturer's standard operations and maintenance manual.

1.07 QUALITY ASSURANCE

- A. Manufacturer: Elevator manufacturer shall be ISO 9001 certified.
- B. Installer: Elevators shall be installed by the manufacturer.
- C. Permits, Inspections and Certificates: The Elevator Contractor shall obtain and pay for necessary Municipal or State Inspection and permit as required by the elevator inspection authority, and make such tests as are called for by the regulations of such authorities. These tests shall be made in the presence of such authorities or their authorized representatives.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Should the building or the site not be prepared to receive the elevator equipment at the agreed upon date, the General Contractor will be responsible to provide a proper and suitable storage area on or off the premises.
- B. Should the storage area be off-site and the equipment not yet delivered, then the elevator contractor, upon notification from the General Contractor, will divert the elevator equipment to the storage area. If the equipment has already been delivered to the site, then the General Contractor shall transport the elevator equipment to the storage area. The cost of elevator equipment taken to storage by either party, storage, and redeliver to the job site shall not be at the expense of the elevator contractor.

1.09 WARRANTY

- A. The elevator contractor's acceptance is conditional on the understanding that their warranty covers defective material and workmanship. The warranty period shall not extend longer than one (1) year from the date of completion or acceptance thereof by beneficial use, whichever is earlier, of each elevator. The warranty excludes: ordinary wear and tear, improper use, vandalism, abuse, misuse, or neglect or any other causes beyond the control of the elevator contractor and this express warranty is in lieu of all other warranties, express or implied, including any warranty of merchantability or fitness for a particular purpose.

1.10 MAINTENANCE AND SERVICE

- A. Maintenance service consisting of regular examinations and adjustments of the elevator equipment shall be provided by the elevator contractor for a period of twelve months (12) after the elevator has been turned over for the customer's use. This service shall not be subcontracted but shall be performed by the elevator contractor. All work shall be performed by competent employees during regular working hours of regular working days. This service shall not cover adjustments, repairs or replacement of parts due to negligence, misuse, abuse or accidents caused by persons other than the elevator contractor. Only genuine parts and supplies as used in the manufacture and installation of the original equipment shall be provided.
- B. The elevator control system must:
 - 1. Provide in the controller the necessary devices to run the elevator on inspection operation.
 - 2. Provide on top of the car the necessary devices to run the elevator in inspection operation.
 - 3. Provide in the controller an emergency stop switch. This emergency stop switch when opened disconnects power from the brake and prevents the motor from running.
 - 4. (Optional) Provide the means from the controller to reset elevator earthquake operation.
- C. Provide system capabilities to enable a remote expert to create a live, interactive connection with the elevator system to enable the following functions:
 - 1. Remotely diagnose elevator issues with a remote team of experts
 - 2. Remotely return an elevator to service
 - 3. Provide real-time status updates via email
 - 4. Remotely make changes to selected elevator functions including:
 - a. Control building traffic: Restrict floor access, remove car from group operation, shut down elevator, select up peak/down peak mode, activate independent service.
 - b. Conserve energy: Activate cab light energy save mode, activate fan energy save mode, shut down car(s).
 - c. Improve passenger experience: Extend door open times, change parking floor, activate auto car full, activate anti-nuisance, advance door opening, door nudging, extend specific floor extended opening time, release trapped passengers.

PART 2 PRODUCTS

2.01 MANUFACTURER

- A. Otis Elevator Company

2.02 DESIGN AND SPECIFICATIONS

- A. Provide machine-roomless holeless hydraulic elevators from Otis Elevator Company. The control system and car design based on materials and systems manufactured by Otis Elevator Company. Specifically, the system shall consist of the following components:
 - 1. The entire hydraulic system and the controller shall be located inside the hoistway. No extra machine room or control closet space is required.
 - 2. Sleep mode operation for LED ceiling lights and car fan.
 - 3. LED lighting standard in ceiling lights and elevator fixtures.
 - 4. Sleep mode operation for LED ceiling lights and car fan.
- B. Approved Installer: Otis Elevator Company

2.03 EQUIPMENT: MACHINE COMPONENTS

- A. The hydraulic system shall be of compact design suitable for operation under the required pressure. The power component shall be mounted in the hydraulic-fluid storage tank. The control valve shall control flow for up and down directions hydraulically and shall include an integral check valve. A control section including control solenoids shall direct the main valve and control: up and down starting, acceleration, transition from full speed to leveling speed, up and down stops, pressure relief and manual lowering. All of these functions shall be fully adjustable for maximum smoothness and to meet contract conditions. System to be provided with a low-pressure switch and a shut-off valve.
- B. The entire hydraulic system with hydraulic-fluid storage tank, power component and valves shall be located in the hoistway pit and be easily accessible for maintenance through an access door in the hoistway wall.
- C. A microprocessor-based controller shall be provided, including necessary starting switches together with all relays, switches, solid-state components and hardware required for operation, including door operation, as described herein. A three (3) phase overload device shall be provided to protect the motor against overloading.
- D. The controller shall be located together with the hydraulic system in the hoistway pit and be easily accessible for maintenance through the same access door that is also used for the hydraulic system.
- E. A manual lowering feature shall permit lowering the elevator at slow speed in the event of power failure or for adjusting purposes.

2.04 EQUIPMENT: HOISTWAY COMPONENTS

- A. Plunger(s) and Cylinder(s): Each cylinder shall be constructed of steel pipe of sufficient thickness and suitable for the operating pressure. The top of each cylinder shall be equipped with a cylinder head with a drip ring to collect any oil seepage as well as an internal guide ring and self-adjusting packing. Each plunger shall be constructed of selected steel tubing or pipe of proper diameter machined true and smooth with a fine polished finish. Each plunger shall be provided with a stop ring electrically welded to it to prevent the plunger from leaving the cylinder. Each plunger and cylinder shall be installed plumb and shall operate freely with minimum friction.
- B. Car Guide Rails: Tee-section steel rails with brackets and fasteners.
- C. Polyurethane type buffers shall be used.
- D. Wiring: Wiring for hoistway electrical devices included in scope of the elevator system, hall panels, pit emergency stop switch, and the traveling cable for the elevator car.
- E. Hoistway Entrances:
 - 1. Frames: Entrance frames shall be of bolted construction for complete one-piece unit assembly. All frames shall be securely fastened to fixing angles mounted in the hoistway and shall be of UL fire rated steel.
 - 2. Sills shall be extruded:
 - a. Aluminum
 - 3. Doors: Entrance doors shall be of metal construction with vertical channel reinforcements.
 - 4. Entrance Finish:
 - a. Paint
 - 5. Entrance Marking Plates: Entrance jambs shall be marked with 4" x 4" 4.02 inch x 102 mm) plates having raised floor markings with Braille located adjacent to the floor marking. Marking plates shall be provided on both sides of the entrance.
 - 6. Sight Guards: Sight guards will be furnished with all doors painted to match with painted doors, painted black for stainless steel doors.

2.05 EQUIPMENT: CAR COMPONENTS

- A. Cab:

1. Standard Cab Options:
 - a. Steel Shell Cab with laminated wall panels
 - 1) laminate to be selected from manufacturer's full catalog of choices.
- B. Car Front Finish: Satin Stainless Steel.
- C. Car Door Finish: Satin Stainless Steel.
- D. Ceiling Type:
 - a. Flat Steel Ceiling with 4 LED Lights
- E. Ceiling Finish:
 - a. Brushed Steel Finish
- F. Emergency Car Lighting: An emergency power unit employing a 6-volt sealed rechargeable battery and totally static circuits shall be provided to illuminate the elevator car in the event of building power failure.
- G. Fan: A one-speed 120 VAC fan will be mounted to the ceiling to facilitate in-car air circulation, meeting A17.1 code requirements. The fan shall be rubber mounted to prevent the transmission of structural vibration and will include a baffle to diffuse audible noise. A switch shall be provided in the car-operating panel to control the fan.
- H. Handrail ; Handrails shall be provided on the side walls, rear wall, side and rear walls of the car enclosure. Handrails shall be: (Select)
 - a. 3/8" x 2" 0.37 inch x 2.01 inch) Flat Tubular Handrail with a Brushed Steel Finish
- I. Threshold:
 - a. Extruded Aluminum
- J. Emergency Exit Contact: An electrical contact shall be provided on the car-top exit.
- K. Guides: Car roller type guides at the top and the bottom.
- L. Platform: Car platform shall be constructed of metal.
- M. The LED ceiling lights and the fan should automatically shut off when the system is not in use and be powered back up after a passenger calls the elevator and pushes a hall button.
- N. Certificate frame: Provide a Certificate frame with a satin stainless steel finish.

2.06 EQUIPMENT: SIGNAL DEVICES AND FIXTURES

- A. Car Operating Panel: A car operating panel shall be provided which contains all push buttons, key switches, and message indicators for elevator operation. The car operating panel shall have a satin stainless steel finish. (An optional Luxury Swing COP is available. A second COP is available)
 1. A car operating panel shall be furnished. It shall contain a bank of round stainless steel, mechanical LED illuminated buttons. Flush mounted to the panel and marked to correspond to the landings served. All buttons to have raised numerals and Braille markings with: (Select)
 - a. Flat Flush Mounted or 1/8" (3mm) satin stainless steel button with blue or white LED illuminating halo
 2. Car Operating Panel: A car operating panel shall be provided which contains all push buttons, key switches, and message indicators for elevator operation. The car operating panel shall have a satin stainless steel finish.
 - a. Raised markings and Braille to the left-hand side of each push-button.
 - b. Car Position Indicator at the top of and integral to the car operating panel.
 - c. Door open and door close buttons.
 - d. Inspection key-switch.
 - e. Elevator Data Plate marked with elevator capacity and car number
 - f. Help Button: The help button shall initiate two-way communication between the car and a location inside the building, switching over to another location if the call is unanswered, where personnel are available who can take the appropriate action.

- 1) Visual indicators are provided for call initiation and call acknowledgement.
- g. Landing Passing Signal: A chime bell shall sound in the car to signal that the car is either stopping at or passing a floor served by the elevator.
- h. In car stop switch (toggle or key unless local code prohibits use)
- i. Firefighter's hat (standard USA)
- j. Firefighter's Phase II Key-switch (standard USA)
- k. Call Cancel Button (standard USA)
- l. Firefighter's Phase II Emergency In-Car Operating Instructions: worded according to A17.1 2000, Article 2.27.7.2.
- B. Car Position Indicator: A digital, LED car position indicator shall be integral to the car operating panel.
- C. Hall Fixtures: Hall fixtures shall be provided with necessary push buttons and key switches for elevator operation. Hall fixtures shall have a
 - 1. Integral Hall fixtures shall feature round stainless steel, mechanical buttons marked to correspond to the landings. Hall fixtures to be located in the entrance frame face or the wall? Buttons shall be in vertically mounted fixture. Fixture shall be satin stainless steel finish.
 - 2. Button Options:
 - a. Flat Flush Mounted or 1/8" (3mm) satin stainless steel button with blue or white LED illuminating halo
- D. Car Lantern and Chime: A directional lantern visible from the corridor shall be provided in the car entrance. When the car stops and the doors are opening, the lantern shall indicate the direction in which the car is to travel and a chime will sound.
- E. Access key-switch at lowest floor in entrance jamb.

PART 3 EXECUTION

3.01 PREPARATION

- A. Take field dimensions and examine conditions of substrates, supports, and other conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A. Installation of all elevator components except as specifically provided for elsewhere by others.

3.03 DEMONSTRATION

- A. The elevator contractor shall make a final check of each elevator operation with the Owner or Owner's representative present prior to turning each elevator over for use. The elevator contractor shall determine that control systems and operating devices are functioning properly.

END OF SECTION 142400

SECTION 21 05 00 - BASIC FIRE PROTECTION REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

- A. This section describes Basic Fire Protection Requirements required to provide for a complete installation of all fire protection systems for this project. This section shall apply to all other Division 21 specification sections as well as all work shown on the drawings.
- B. It is the intent of the Fire Protection Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.
- C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative and the Authority Having Jurisdiction.
- D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.
- E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 21.

1.3 DESCRIPTION OF WORK

- A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete fire protection systems required by these specifications and/or shown on the drawings of the contract.
- B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping, etc.

1.4 QUESTIONS OF INTERPRETATION

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- B. The Architect/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of bid.
- B. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of three-dimensional objects. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies should be identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
- C. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of materials or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.
- D. If there is a conflict between manufacturer's recommendations and the Contract Documents, the manufacturer's recommendations shall govern with no additional cost to the Owner.

1.6 PERMITS

- A. The Contractors shall familiarize themselves with all requirements regarding all permits, fees, etc., and shall comply with them. All permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.
- B. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.7 QUALITY ASSURANCE

- A. Installers shall have at least 2 years of successful installation experience on projects with fire protection installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other fire protection sections.
- B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Fire Protection Sections.
- C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.

- D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.
- F. Comply with provisions of NFPA 13, NFPA 14, and NFPA 24, including all addenda.
- G. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.

1.8 REFERENCES

- A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall, at minimum, conform to the following as applicable:
 1. Safety and Health Regulations for Construction.
 2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
 3. ACGIH - American Conference of Governmental Industrial Hygienists.
 4. AIHA - American Industrial Hygiene Association.
 5. AMCA - Air Movement and Control Association.
 6. ANSI - American National Standards Institute.
 7. ASA - Acoustical Society of American.
 8. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
 9. ASME - The American Society of Mechanical Engineers.
 10. ASTM - American Society of Testing and Materials.
 11. CAGI - Compressed Air and Gas Institute.
 12. CTI - Cooling Tower Institute.
 13. EJMA - Expansion Joint Manufacturers Association.
 14. ETL - Engineering Tests Laboratory.
 15. HI - Hydraulic Institute.
 16. HYD I - Hydronics Institute.
 17. ICBO - International Conference of Building Officials.
 18. ICC – International Code Council.
 19. NEBB - National Environmental Balancing Bureau.
 20. NEC - National Electrical Code.
 21. NEMA - National Electrical Manufacturers Association.
 22. NFPA - National Fire Protection Association.
 23. NSF - National Sanitation Foundation.
 24. SAE - Society of Automatic Engineers.
 25. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
 26. TEMA - Tubular Exchanger Manufacturers Association.
 27. UL - Underwriters Laboratories, Inc.
 28. International Plumbing Code.
 29. International Mechanical Code.
 30. Other governing, state, and local codes that apply.

1.9 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and "Special Conditions".
1. **See Section 21 13 13 for special submittal procedures for sprinkler/standpipe system submittals.**
- B. The Architect/Engineer's review of submittals, including any corrections or comments made on the shop drawings during the review process, do not relieve Contractor from compliance with requirements of the Contract Documents. The review is only a review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions; selecting fabrication process and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Architect/Engineer's review of those drawings.
- C. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Architect/Engineer. All such portions of the work shall be in accordance with reviewed submittals and the associated manufacturer recommendations.
- D. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Fire Protection Sections.
1. Certified performance and data with system operating conditions indicated.
 2. All equipment items shall be marked with the same item number as used on drawings or schedules.
 3. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
 4. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
 5. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
 6. Maintenance Data: Submit maintenance data and parts list for each fire protection equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.
- E. Coordination drawings
1. Drawings:

- a. Provide coordination in determining adequate clearance and space requirements for fire protection equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.
 - b. Provide coordination drawings indicating structural components, reflected ceiling layout, fire protection items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.
 - c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.
 - d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.
 - e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire protection and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.
 - f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.
2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:
 - a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.
 - b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.
 - c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.
 3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).
 - a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.
 - b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):

- 1) Roof drain leaders
- 2) Large waste piping
- 3) Sprinkler mains
- 4) Equipment located above the ceiling
- 5) Heating hot water piping
- 6) Chilled water piping
- 7) Conduit runs 2 inches and larger
- 8) Cable tray
- 9) Bus duct
- 10) Recessed light fixtures
- 11) Building wiring or cable trays
- 12) Ceiling heights as shown in contract documents and thickness of system
- 13) Soffits (including framing of supports)
- 14) Access points and clearances required
- 15) Access panels
- 16) Valves
- 17) Dampers
- 18) Coils
- 19) Ductwork
- 20) Fire-rated wall, partition, and floor penetrations
- 21) Steam and condensate piping
- 22) Space allotted for future utilities
- 23) Equipment in mechanical and electrical spaces

c. Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.

4. The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.
5. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.
6. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.
7. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

F. Provide separate shop drawing submittals for the following items:

1. Section 21 05 00:

Submittal Requirement:	Date Submitted:
Permits	
Welding certificates	
Warranties	
As-built documents	
Pipe pressure test logs	
Operation and maintenance manuals	
Close-out / walk-through documentation	
Training seminar documentation	

2. Section 21 05 19:

Submittal Requirement:	Date Submitted:
Pressure gauges	

3. Section 21 05 29:

Submittal Requirement:	Date Submitted:
Pipe supports, anchors, sleeves, and hangers	
Equipment curbs, supports, and hangers	
Mechanical seals	
Fire sealants	

4. Section 21 05 53:

Submittal Requirement:	Date Submitted:
Fire protection identification materials	
Valve schedule	

5. Section 21 13 13:

Submittal Requirement:	Date Submitted:
Fire hydrant flow test report	
Fire protection equipment and materials	
Sprinklers	
Standpipe hose connections and hose connection cabinets	
Fire protection piping and sprinkler location plan(s)	
Hydraulic calculations	
Hydrostatic test report(s)	

1.10 SUBSTITUTES

- A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified. The Contractor's options in selecting materials and equipment are limited by requirements of the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects.
- B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing. Associated fire protection and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted fire protection spaces. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
- C. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.
- D. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.
- E. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.
- F. Final determination regarding substitutions shall be by the Architect/Engineer.

1.11 WARRANTY

- A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Fire Protection Sections.

1.12 CLOSE OUT AND OPERATION INSTRUCTIONS

- A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.
- B. Systems shall not be used for temporary operation during construction without written approval from the Architect/Engineer and the Authority Having Jurisdiction. If approved and used during construction, all systems must be properly maintained and operated according to manufacturer recommendations. Immediately prior to turnover to the Owner, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.
- C. Any system placed in temporary operation for testing during construction shall be properly maintained and operated by the Contractor.
- D. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.
- E. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.
- F. All tests shall be made after notification to and in the presence of the Owner's representative.
- G. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.
- H. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.
- I. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of fire protection equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.
- J. At the time of substantial project completion, turn over the prime responsibility for operation of the fire protection equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.
 - 1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.13 RECORD DOCUMENTS

- A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:
1. The Fire Protection Contractor shall provide the Owner with as-built drawings for pipe mains and branches, size and location, for both exterior and interior; locations of control valves and supervisory switches; drain valves; and indicate all devices requiring periodic maintenance or repair.
 2. All fire protection systems as described in the Specifications and/or shown on the drawings.
 3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located. Valve location diagrams, complete with valve tag chart. Refer to Division 21 Section "Fire Protection Identification." Indicate actual inverts and horizontal locations of underground piping.
 4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.

1.14 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 4. Servicing instructions and lubrication charts and schedules.
- B. Provide electronic copies, preferably in Adobe Acrobat Portable Document Format (pdf), of all maintenance manuals to Temperature Control Contractor for use in EMCS front-end system. Provide data in file types compatible with EMCS.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 JOBSITE SAFETY

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

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Use proper lifting equipment where size/weight requires handling by such means.
- D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.
- E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.
- F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
- G. Fire Protection Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.
- H. Any material that is damaged during delivery, storage, handling, or installation shall be brought to the attention of the Architect/Engineer for review of its acceptability in the project.
 - 1. The Architect/Engineer shall be the sole and final judge as to the suitability of damaged items.

3.3 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.4 COORDINATION

- A. Sequence, coordinate, and integrate installations of fire protection materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- B. Coordinate the fire protection work with work of the different trades so that:
 - 1. Interferences between fire protection, mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
 - 2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of fire protection and other equipment will be provided.
 - 3. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:

- a. Light fixtures.
 - b. Gravity flow piping, including steam and condensate.
 - c. Equipment requiring access, including terminal units, fire/smoke dampers, and piping valves.
 - d. Ductwork.
 - e. Electrical busduct.
 - f. Electrical cable trays, including access space.
 - g. Piping (hydronic and plumbing).
 - h. Sprinkler/standpipe piping.
 - i. Electrical conduits and wireway.
4. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.
- C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
- D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.5 FIRE PROTECTION INSTALLATIONS

- A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.
- B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.
- C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.
- D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for fire protection installations.
- E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom.
- F. Coordinate connection of fire protection systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
- H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

- I. Install fire protection equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- K. Welding, sweating, or brazing operations
 - 1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
 - 2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials cannot be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
 - 3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.
 - 4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
 - 5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.6 ACCESSIBILITY

- A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.7 LUBRICATION AND TOOLS

- A. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.8 START-UP

A. PIPING SYSTEMS PRESSURE TESTING

- 1. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:
 - a. Local Authority Having Jurisdiction
 - b. Owner's Representative
 - c. Mechanical Engineer / Architect
 - d. General Contractor's Foreman

2. Removal of pressure charge and associated drain down shall also be witnessed.
3. Fire protection contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.
4. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.
5. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.
6. Entire system shall be properly vented before test is commenced.
7. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections. At minimum, however, pipe systems should be tested at the following pressures and all installed components must be rated at this pressure at the actual operating temperature:

a. Sprinkler and/or standpipe piping 200 psig

8. Submit completed "Pipe Pressure Test Log" provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY

3.9 GENERAL CONTRACTOR - FIRE PROTECTION EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to all valves and flow switches and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
2. The plans indicate the location of all anticipated access panels. The Division 21 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 21 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the fire protection and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.
3. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
2. The Division 21 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of fire protection work.

3. Division 21 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 21 Contractor shall be liable for all associated costs of cutting and patching for fire protection work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for fire protection installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. **All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.**
9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of fire protection equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

1. Division 21 Contractor shall perform all excavation and backfilling necessary to install the required fire protection work. Coordinate the work with other excavating and backfilling work in the same area.
2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to insure worker safety, proper installation of fire protection work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.
4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
7. Final Backfill shall be as follows:
 - a. Outside Building Under Paved Areas: Granular material specified in Division 2.

- b. Outside Building and Not Under Paved Areas: Clean soil free of vegetable matter and foreign material or crushed limestone. In planted areas backfill to a point 6" below finished grade. Owner will provide topsoil to finished grade.
- 8. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.
 - 9. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
 - 10. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
 - 11. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
 - 12. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
 - 13. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Fire Protection Contractor.

D. Concrete Bases

- 1. Minimum 4" high concrete housekeeping pads shall be provided under all floor-mounted fire protection equipment, regardless of whether explicitly shown on the Drawings. Concrete inertia pads with spring isolators shall be provided for all base-mounted pumps and air compressors installed on any floors which are not slab-on-grade. Inertia pads and isolators shall be sized by the equipment manufacturer if specific information is not provided in the Contract Documents.
- 2. Division 21 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all fire protection equipment bases. The Division 21 Contractor shall be liable for all associated costs to install the fire protection equipment bases upon failure to notify the General Contractor prior to bid submission.
- 3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.
- 4. All equipment shall be mechanically fastened to concrete bases.

E. Roof curbs, roof support for fire protection equipment and roof penetrations.

- 1. Verify, prior to submitting bid, the number, size, and location of all roof curb and roof supports and the location of all roof penetrations. Provide all roof deck-mounted equipment, pipe supports, and pipe penetrations. Cut roof deck for pipe and duct penetrations, unless noted otherwise. Provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
- 2. Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
- 3. All roof curbs, supports, and rails shall be sized to keep equipment a minimum of 24" above the roof insulation membrane in order to limit snow accumulation at or near equipment.

F. Painting

1. The General Contractor is to field paint fire protection equipment and materials in specified areas as noted on the fire protection plans, fire protection schedules and in the specifications. Division 21 Contractor is to coordinate the painting of these items with the General Contractor. The Fire Protection Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 21 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.10 ELECTRICAL-FIRE PROTECTION EXTENT OF WORK

- A. The responsibility of work specified under Division 21 and 26 is clarified under Section 21 05 13, "Electrical Requirements for Fire Protection Equipment. Division 21 Contractor is to coordinate all electrical requirements prior to ordering powered fire protection equipment.

END OF SECTION

PIPE PRESSURE TEST LOG											
PROJECT:											
BUILDING:						GENERAL CONTRACTOR:					
CLARK ENERSEN PROJECT NUMBER:						MECHANICAL CONTRACTOR:					
TEST INFORMATION						TEST PRESSURE					
TEST DATE	PIPI NG SYS TEM	AREA TESTED	TEST MEDIA (WATER OR AIR)	TEST DURATION (MINUTES)	PRESSURE GAGE NUMBER	INITIAL (PSIG)	FINAL (PSIG)	TESTED BY	WITNESSED BY	PASS / FAIL (P/F)	COMMENTS

ADDITIONAL

COMMENTS:

PRESSURE GAGE INFORMATION											
GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE	GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE

NOTE: USE MULTIPLE FORMS IF NECESSARY

SECTION 21 05 13 - ELECTRICAL REQUIREMENTS FOR FIRE PROTECTION EQUIPMENT

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.
- B. Related Sections: Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.2 SUMMARY

- A. This section specifies the basic requirements for electrical components which are an integral part of packaged fire protection equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged fire protection equipment. In addition, this section covers necessary coordination issues between fire protection and electrical disciplines. All fire protection and electrical construction documents must be completely reviewed by the Fire Protection and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for fire protection equipment are scheduled on the Drawings.

1.3 REFERENCES

- A. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:
 - 1. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
 - 2. NEMA Standard 250: Enclosures for Electrical Equipment.
 - 3. NEMA Standard KS 1: Enclosed Switches.
 - 4. National Electrical Code (NFPA 70).

1.4 SUBMITTALS

- A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

1.5 QUALITY ASSURANCE

- A. Electrical components and materials shall be UL labeled and listed.

2. PRODUCTS

2.1 DIVISION-21 RESPONSIBILITY

- A. Furnish and install all electrical control circuit conduits and wiring and control devices required to perform the equipment control functions as specified in Division-21.
- B. All electrical equipment provided, including the wiring and installation of electrical equipment shall be in strict accordance with the requirements of this Section and Division-26.

3. EXECUTION

3.1 CONTRACTOR COORDINATION

- A. General contractor is responsible for coordination of all subcontractors and associated scopes of work.

END OF SECTION

SECTION 21 05 19 - FIRE PROTECTION GAUGES

1. GENERAL

1.1 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Piping pressure and temperature test plugs.

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

- A. REFERENCES
- B. SUBMITTALS
- C. PROJECT RECORD DOCUMENTS
 - 1. Accurately record actual locations of instrumentation.

1.3 ENVIRONMENTAL REQUIREMENTS

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

2. PRODUCTS

2.1 PRESSURE GAUGES

- A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.
- B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.
- C. Connector: Brass, 1/4-inch NPS.
- D. Scale: White coated aluminum, with permanently etched markings.
- E. Accuracy: Plus or minus 1 percent of range span.
- F. Range: Conform to the following:
 - 1. Vacuum: 30 inches Hg to 15 psi.
 - 2. All fluids: 2 times operating pressure.

2.2 PRESSURE GAUGE ACCESSORIES

- A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.

- B. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

2.3 PIPING PRESSURE AND TEMPERATURE TEST PLUGS

- A. Test Plugs shall be nickel-plated brass body, with 1/2-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig.
- B. Core Material: Conform to the following for fluid and temperature range:
 - 1. Air, Water, Oil, and Gas, 20 to 200 deg F: Neoprene.

3. EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturer's instructions and NFPA 13 and NFPA 14 requirements.

3.2 PRESSURE GAUGES

- A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.
- B. Install as shown on plans, and elsewhere as indicated.
- C. Pressure Gauge Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.

3.3 TEST PLUGS

- A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.4 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 21 05 29 - FIRE PROTECTION HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

- A. Pipe and equipment hangers, supports, anchors, saddles and shields.
- B. Sleeves and seals.
- C. Mechanical sleeve seals.
- D. Sealants, firestop insulation, putty and compounds.
- E. Related Requirements:
 - 1. Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems" for vibration isolation devices and seismic restraints.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

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

1.5 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

- A. REFERENCES
 - 1. NFPA 13 and 24.
 - 2. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture.
 - 3. MSS SP-69 – Pipe Hangers and Supports – Selection and Application.
 - 4. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

B. SUBMITTALS

C. DELIVERY, STORAGE, AND HANDLING

2. PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 PIPE HANGERS AND SUPPORTS

- A. Fire Protection and Standpipe Piping:
 - 1. Conform to International Fire Code, NFPA 13, NFPA 14, NFPA 24, MSS SP58, MSS SP69 and MSS SP89, as applicable.
- B. Hangers and Supports:
 - 1. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
 - 2. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 - 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 4. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 - 5. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
 - 6. Vertical Support: Steel riser clamp.
 - 7. Floor Support for Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
 - 8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.3 ACCESSORIES

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

2.4 INSERTS

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

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Internally Threaded Screw Anchors: Internally threaded, self tapping screw anchors, Power Fasteners Snake or approved equivalent.
 - 1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.6 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage 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.

2.7 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

- A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.
- B. Firestop Putty: Non-hardening, non shrinking, UL listed.
- C. Firestop Compounds: Cementitious material, non-shrinking, UL listed.
- D. Sealants:
 - 1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
 - 2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.8 MECHANICAL SEALS

- A. Mechanical Seals: Modular mechanical type, consisting of interlocking EPDM synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with type 316 stainless steel bolts and reinforced plastic polymer pressure plates which cause rubber sealing elements to expand when tightened, providing a watertight and gas-tight seal and electrical insulation. Provide Advance Products & Systems Model Innerlynx or equivalent.
 - 1. A sleeve shall be provided for each mechanical seal.

- a. Thermoplastic sleeves: Sleeve shall have smooth walls and shall be made of molded non-metallic high density polyethylene (HDPE) with an integral solid water stop, Advance Products & Systems Model PWS or equivalent.
- b. Steel sleeves: Sleeve shall have smooth walls, shall be made of Schedule 40 steel with an integral welded solid water stop, and shall have corrosion-resistant coating, Advance Products & Systems Model GWS or equivalent.

3. EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 13 and 24.

3.2 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- 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.

3.3 PIPE HANGERS AND SUPPORTS

- A. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- B. Support horizontal piping as scheduled.
- C. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Division 21 Contractor and other trades.
- D. Install hangers to provide 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. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- J. Support riser piping independently of connected horizontal piping.
- K. Provide copper plated hangers and supports for non-insulated copper pipe.
- L. Design hangers for pipe movement without disengagement of supported pipe.
- M. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- N. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.

3.4 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrate weather or waterproofed walls and floors.
- B. Provide acoustical lead flashing around pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.

3.5 SLEEVES

- A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe sleeves are not required for penetrations through non-rated concealed partitions.
- B. At the Contractor's option, pipe sleeves may be omitted if the wall or floor is core drilled, except in areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.).
- C. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Sleeves through floors shall be grinded flush with finish floor level. In areas potentially exposed to wet conditions (such as mechanical rooms, loading dock, generator room, penthouse, kitchen, etc.), sleeve shall extend a minimum of 2" above finish floor.
- F. Where piping penetrates non-rated ceilings or walls, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
- G. Seal pipe penetrations through non-rated floors.

1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
 2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
- H. Where piping penetrates rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.
- I. Install chrome plated steel escutcheons on piping at finished surfaces.
- J. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.
- 3.6 HANGER SCHEDULES
- A. Reference International Fire Code and NFPA 13 where applicable.

END OF SECTION

SECTION 21 05 53 - FIRE PROTECTION IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

- A. REFERENCES
- B. RELATED SECTIONS
- C. SUBMITTALS
- D. QUALITY ASSURANCE
- E. PROJECT RECORD DOCUMENTS

- 1. Record actual locations of tagged valves.

2. PRODUCTS

2.1 NAMEPLATES

- A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.
- B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.
- B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.
- C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

- A. Color: Conform to ASME A13.1.
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed.

3. EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic tape pipe in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.
- D. Identify hose connections cabinets and drain termination points with plastic nameplates.
- E. Identify tags on backflow preventers, drain valves, test connections, risers, alarm devices, and hose connections with tags. Label each valve as normally open or normally closed, as appropriate.
- F. Identify valves in main and branch piping with tags.
- G. Identify piping, concealed or exposed, with plastic tape pipe markers. For pipes $\frac{3}{4}$ " and smaller, identify piping with tags. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locate identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.

END OF SECTION

SECTION 21 13 13 - FIRE PROTECTION SYSTEM

1. GENERAL

1.1 SECTION INCLUDES

- A. Pipe, fittings, valves, and connections for a combined automatic wet-pipe sprinkler system.
- B. System design, installation, and certification.
- C. Fire department connections.
- D. Post indicator valves.
- E. Water main connections.

1.2 REFERENCE SECTION 21 05 00 FOR THE FOLLOWING:

A. REFERENCES

- 1. NFPA 13 - Installation of Sprinkler Systems.
- 2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances

B. PROJECT RECORD DOCUMENTS

- 1. Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.

C. DELIVERY, STORAGE, AND HANDLING

- 1. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. The Contractor shall be responsible for determining the requirements for seismic control measures to be applied to the fire protection system specified herein. Seismic protection criteria use to determine seismic control requirements of all mechanical, electrical, and plumbing systems shall be determined by the applicable code adopted in the project jurisdiction. Where not already determined within the contract documents, the Contractor shall be responsible for contracting a licensed professional engineer to establish building site class, seismic use group, occupancy

category, seismic zone or any other criteria necessary to determine the requirements for seismic control measures for the fire protection system.

1.4 ACTION SUBMITTALS

- A. Seismic Control Measure Analysis: The Contractor shall provide an analysis determining the requirements or exemption for seismic control measures for the fire protection system. The analysis shall be signed and sealed by a licensed professional structural engineer.

1. The analysis shall at a minimum include the following:

- a. For projects permitted under International Building Code:

- 1) Seismic Use Group or Building Category
 - 2) Seismic Design Category
 - 3) Site Class
 - 4) Design Spectral Response Acceleration Values

- b. For projects with equipment mounted outdoors and subject to wind restraint requirements:

- 1) Basic Wind Speed.
 - 2) Building Classification Category
 - 3) Minimum 10lb/sq.ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

- B. **Note the following procedure for fire protection submittals:**

- C. Product Data:

1. For each type of product.

- a. Include construction details, material descriptions, dimensions of individual components and profiles.
 - b. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - c. Manufacturer standard/custom color chart for concealed sprinkler cover systems.

- D. Shop Drawings:

1. Prepare in accordance with NFPA 13 section "Working Plans."

- a. Include plans, elevations, and sections of the system piping and details.
 - b. Include detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe and fittings, as well as the delineation of the standard-pressure and high-pressure portions of the fire-protection system.
 - c. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

2. Prepare computer-generated hydraulic calculations in accordance with the following:

- a. Name of hydraulic program used.
 - b. Water supply information, including fire hydrant flow test data report.
- 3. Submit documents and calculations to Owner and Engineer for approval. Documents and calculations shall be signed and sealed by qualified professional engineer, licensed in the State of Arkansas, responsible for their preparation.
 - a. After initial submittal has been reviewed by the Owner and Engineer and the review comments have been incorporated, submit all information to the authority having jurisdiction (local and state Fire Marshal) for approval. Coordinate submittal to authority having jurisdiction with the fire alarm shop drawing submittal. Submit proof of approval to Architect/Engineer
- 4. Include diagrams for power, signal, and control wiring.
- E. Delegated Design Submittals: For fire-protection systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Fire-protection system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.
- B. Seismic Qualification Certificates: For fire-protection equipment, 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. Qualification Data: For qualified Installer and professional engineer.
- D. Design Data: Approved fire-protection piping working plans, prepared in accordance with NFPA 13 including documented approval by AHJs, and including hydraulic calculations.
- E. Welding certificates.
- F. Field Test Reports:
 - 1. Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 - 2. Fire-hydrant flow test report.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-protection systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
 - 2. System control valves.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing fire-protection systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by qualified professional engineer licensed in the State of Arkansas.
- B. Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.
- C. All grooved fittings, valves, and specialties shall be compatible with the specified coupling.
- D. Equipment and Components: Bear UL and FM label or marking.
- E. Valves: Bear UL and FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.

1.9 FIELD CONDITIONS

- A. Interruption of Existing Fire-Protection Service: Do not interrupt fire-protection service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire-protection service in accordance with requirements indicated:
 - 1. Notify Owner and Construction Manager no fewer than seven days in advance of proposed interruption of fire-protection service.
 - 2. Do not proceed with interruption of fire-protection service without Construction Manager's and Owner's written permission.

2. PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. System to provide coverage for the entire building to include overhangs as required by NFPA.

- B. Wet pipe sprinkler system conforming to NFPA 13 Light Hazard, Ordinary Hazard – Group 1, and Ordinary Hazard – Group 2 occupancy requirements. See drawings for zoning requirements and additional information.
- C. Determine volume and pressure of incoming water supply from water flow test data. Obtain water flow test data from Owner's Representative. See drawings for further information.
- D. Interface system with building fire and smoke alarm system. Fire alarm specialties related to the sprinkler system (i.e. flow switches, supervisory valves, etc.) shall be provided and installed by the sprinkler contractor. However, these devices shall be wired under Division 26.
- E. Provide fire department connections as indicated. Coordinate fire department connection type with local fire department.
- F. Although not specifically specified, the Contractor shall provide and install all supplementary and/or miscellaneous items and devices as required for a complete, code compliant and operational sprinkler.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-protection system piping to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7.
- B. Fire-Protection System Components, Devices, and Accessories: Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Fire-protection system equipment, specialties, accessories, installation, and testing to comply with NFPA 13 and ASME A17.1.
- E. Standard-Pressure Piping System Component: Listed for 175 psig minimum working pressure.
- F. Delegated Design: Engage a qualified professional engineer licensed in the State of Arkansas to design fire-protection systems.

1. Fire-Hydrant Flow Test:

- a. Perform fire-hydrant flow test and record the following conditions:

- 1) Date:
- 2) Time
- 3) Performed by: Operator's name and associated firm's name.
- 4) Location of Residual Fire Hydrant R:
- 5) Location of Flow Fire Hydrant F:
- 6) Static Pressure at Residual Fire Hydrant R: in psig.
- 7) Measured Flow at Flow Fire Hydrant F: in gpm.
- 8) Residual Pressure at Residual Fire Hydrant R: in psig.

- b. Fire-hydrant flow test must be performed within previous [12] months prior to completion of design documents and hydraulic calculations.
- 2. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
- 3. Sprinkler Occupancy Hazard Classifications:
 - a. Refer to Fire Protection drawings.
- 4. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500 sq. ft. area.
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm/sq. ft. over 1500 sq. ft. area.
 - c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm/sq. ft. over 1500 sq. ft. area.
 - d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm/sq. ft. over 2500 sq. ft. area.
 - e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm/sq. ft. over 2500 sq. ft. area.
 - f. Special Occupancy Hazard: As determined by AHJs.
- 5. Maximum protection area per sprinkler in accordance with UL listing.
- 6. Total Combined Hose-Stream Demand Requirement: In accordance with NFPA 13 unless otherwise indicated:
 - a. Light-Hazard Occupancies: 100 gpm for 30 minutes.
 - b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.
 - c. Extra-Hazard Occupancies: 500 gpm for 90 to 120 minutes.
- 7. Minimum residual pressure at each hose-connection outlet is as follows:
 - a. NPS 1-1/2 Hose Connections: 65 psig.
 - b. NPS 2-1/2 Hose Connections: 100 psig.

G. Obtain documented approval of fire-protection system design from AHJs.

2.3 SPRINKLER PIPING, BURIED

- A. Ductile Iron Pipe: ASTM A377, AWWA C106, Class 150.
 - 1. Fittings: AWWA C110, ductile iron, standard thickness.
 - 2. Joints: Mechanical joints with ANSI/AWWA C111 rubber gasket.

2.4 SPRINKLER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53 or ASTM A795; Schedule 40 black steel.
 - 1. Steel Fittings: ANSI/ASME B16.5, steel flanges and fittings.
 - 2. Cast Iron Fittings: ANSI/ASME B16.4, screwed fittings.
 - 3. Malleable Iron Fittings: ANSI/ASME B16.3, screwed type.
 - 4. Joints: Flanged, grooved or threaded.
 - 5. Mechanical Grooved Couplings: Victaulic Installation-Ready 107N and 009-EZ or 005 Firelock Rigid with rolled grooved fittings, no equivalent. Cut grooves or O-ring type socket fittings are not allowed.

6. Mechanical weld-o-lets and thread-o-lets are allowed.
7. Mechanical Tee fittings are not allowed unless approved by the Project Engineer. |

B. At the option of the contractor the Victaulic FireLock IGS System with "Installation-Ready™" fittings and couplings may be used for NPS 1" (DN 25) Schedule 40 carbon steel pipe in fire protection applications. System rated for a working pressure to 365 psi (2517 kPa).

1. Groove: IGS "Innovative Groove System" groove with shortened "A" dimension and tapered groove backside for ease of installation.
2. Grooving Tool: Victaulic RG2100, with IGS Confirmation Gauge.
3. Fittings: Ductile iron housing conforming to ASTM A-536, Grade 65-45-12. Orange enamel coated or galvanized.
4. Victaulic Style 101 (90-degree elbow), Style 102 (tee), and Style 108 (coupling) with Installation-Ready™ ends.
5. Style 108 single-bolt coupling provided with EPDM Type A pressure responsive gasket with Vic-Plus lubricant, and ASTM A449 compliant electroplated steel bolt and nut. CrMo alloy steel coupling linkage.
6. Thread x Groove adapter fittings and welded outlets with IGS grooved end, ASTM A53, grade A.

C. Pipe hangers shall conform to NFPA standard 13 requirements and shall be FM/UL approved for use in fire sprinkler systems. Refer to specification section 21 05 29 for additional information.

2.5 FLEXIBLE SPRINKLER HOSE

A. Basic Use:

1. Flexible stainless-steel hose assemblies and a bracketing system that connect sprinkler heads to the branch lines. Each flexible hose assembly shall be provided with an open-gate mounting bracket and a 1-piece, leak tested sprinkler drop. The mounting bracket shall be compatible with application and allow installation before the ceiling tile is in place.
2. Flexible hose assembly shall be pressure/leak tested system available in 2' – 6' hose lengths.
3. Hose bend radius to 2" for AH2 or AH2-CC, and 3" for AH1.
4. All flexible hose assembly shall Factory Mutual (FM 1637) approved and UL 2443 listed and are manufactured in an FM/UL audited facility.
5. Zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping.
6. Compatible with any FM/UL approved sprinkler head.
7. 100% leak tested system.
8. Industrial grade, all welded, no O-ring construction, with all stainless steel components.
9. Adjustable height and sprinkler alignment / center-of-tile uniformity.
10. Rated up to 300 psi with no additional hangers required.
11. Approved for use in suspended ceiling systems with light, medium and heavy load grids (ASTM C635, C636)
12. True-bore 1" internal corrugated hose diameter, which produces friction loss values similar to hard pipe armovers.
13. IBC and SEI/ASCE 7-02 compliant for sprinklers installed in seismic design classes C and D/E/F.

B. Composition and Materials:

1. Every flexible hose assembly shall come complete with the flexible hose. Each connection shall be made from 100% factory tested Type 304 stainless steel. The hose nipples shall be 304 stainless steel and be fully welded. Flexible hose assembly shall be leak tested to 175 psi. Hose factory tested to 400 psi (2760 kPa).
2. The bracket system shall be factory or shop fabricated made from galvanized sheet metal and is approved and compatible for application. Coordinate with flexible hose manufacturer.

C. Flexible fire sprinkler hose is not allowed for use in an exposed ceiling, all areas that are visible shall be hard piped.

D. Basis of Design: Victaulic Vic-Flex.

2.6 GATE VALVES

- A. Up to and including 2 Inches: Bronze body, bronze trim, non-rising stem, handwheel, inside screw, solid wedge disc, threaded ends, class 175, UL/FM approved.
- B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, solid wedge disk, flanged or grooved ends, class 175, UL/FM approved.

2.7 ANGLE VALVES

- A. Up to 2 Inches: Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable composition disc, screwed ends, with backseating capacity, class 175, UL/FM approved.
- B. Over 2 Inches: Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc, class 175, UL/FM approved.

2.8 BALL VALVES

- A. Up to and including 2 Inches:
 1. Bronze two piece body, stainless steel ball, Teflon seats and stuffing box ring, lever handle threaded ends, blowout proof stem, full port, 600 WOG, UL/FM approved.

2.9 BUTTERFLY VALVES

- A. Cast or ductile iron body, aluminum bronze disc, resilient replaceable EPDM seat, grooved, wafer, or lug ends, extended neck handwheel and gear drive and integral indicating device and built-in tamper proof switches, 300-psi rated, UL/FM approved.

2.10 CHECK VALVES

- A. Up to and including 2 Inches: Bronze swing disc, screwed ends, class 200, UL/FM approved.
- B. Over 2 Inches: Iron body, stainless steel or bronze trim, spring-assisted swing disc for vertical or horizontal installation, renewable disc and seat, flanged, screwed or grooved ends, UL/FM approved.

2.11 SPRINKLER SYSTEM CONTROL VALVES

- A. Cast- or ductile-iron body, flanged or grooved ends, 225 psig minimum pressure rating, UL/FM approved.

2.12 DRAIN VALVES

- A. Brass ball valve with cap and chain, 3/4 inch hose thread, UL/FM approved.

2.13 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate electrically operated alarms, with pressure retard chamber and variable pressure trim. Valve internal components shall be replaceable with valve in the installed position.
- B. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.
- C. Water Flow Switch: Electrically supervised vane type switch for mounting horizontal or vertical, with two contacts.
- D. Fire Department Connection:
 - 1. Type: Flush mounted wall type with polished brass finish. Coordinate exact type with local fire department.
 - 2. Outlets: Two way with thread size to suit local fire department hardware; threaded dust cap and chain of matching material and finish. Cover plate and eyelet cover not acceptable.
 - 3. UL/FM approved, class 250 Check valve with 3/4 inch automatic drip drain, connected to drain.
 - 4. Drain: Automatic drip, discharged location(s) shown on drawings.
 - 5. Escutcheon Engraving for Fire Department Connection: "AUTO SPRINKLER".
 - 6. Supplemental Signage: Custom engraved polished brass sign secured to the building directly adjacent to fire department connection, reading "FDC SERVES SPRINKLER".
 - 7. At the low point near each fire department connection, provide a 90-degree elbow with drain connection to allow for localized system drainage to prevent freezing.
- E. Indicator Post: UL 789, FM approved, vertical type, cast iron body with operating wrench, extension rod. Provide adjustable cast iron barrel of sufficient length to allow for bury depth of valve and surface elevation. Basis of Design: Victaulic Series 772 gate valve with Series 774 post.
- F. Curb stops: Bronze body, ground key plug or ball, wide tee head with inlet and outlet to match service piping. Conform to all local water department requirements.
 - 1. Service box for curb stop: Cast iron box with telescoping top section as required for valve bury depth. Include cover with lettering "WATER," and bottom section with base of size to fit over curb stop and barrel. Conform to all local water department requirements.
- G. Tapping sleeve and valve: Complete assembly, including two piece cast iron bolted sleeve with outlet connections suitable for use with size and type of piping being connected.

2.14 FLOW ALARM SWITCHES

- A. FM/UL approved, water flow switches which will close contact when flow is detected.

2.15 SPRINKLERS

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.
3. Sprinklers shall be glass bulb type, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation. (Wrenches shall be provided by the sprinkler manufacturer that directly engage the cast wrench boss.)

B. Automatic Sprinklers with Heat-Responsive Element:

1. Nonresidential Applications: UL 199.
2. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
3. High or *intermediate* temperature *sprinklers* heads shall be provided in all mechanical rooms, elevator equipment rooms, and emergency generator rooms, attics and elsewhere when elevated ambient temperatures might be expected.

C. Sprinkler Finishes:

1. Chrome plated.
2. Bronze.
3. Painted.

D. Special Coatings:

1. Wax.
2. Lead.
3. Corrosion-resistant paint.

E. **Install concealed sprinkler heads in all areas with ceilings (lay-in and gyp). Install upright sprinkler heads in all areas without ceilings.**

F. Cover System for Sprinkler Piping:

1. Description: System of support brackets and covers designed to protect sprinkler piping.
2. Brackets: Per cover manufacturer.
3. Covers: Factory-fabricated steel cover with concealed attachment clamps.

a. Cold-Rolled Steel

- 1) Zinc galvanized, factory treated, and factory painted in colors selected by Architect from manufacturers standard/custom colors.

G. Sprinkler Guards:

1. Provide sprinkler head guards in mechanical rooms, high traffic areas and areas where heads are lower than 10'- 0" above the finished floor and/or where heads may be vandalized.
 1. Standard: UL 199.
 2. Type: Wire cage with fastening device for attaching to sprinkler.
 3. Guards shall be listed, and supplied for use with the sprinkler by the sprinkler manufacturer.
 - H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 1. Ceiling Mounting: Chrome-plated steel, one piece, flat
 2. Sidewall Mounting: Chrome-plated steel one piece, flat.
- 2.16 VALVE SUPERVISORY SWITCHES
- A. Standard: UL 346
 - B. Type: Electrically supervised
 - C. Components: Single-pole, double-throw switch with normally closed contacts.
 - D. Design: Signals that controlled valve is in other than fully open position.
- 2.17 HOSE CONNECTIONS
- A. Connection: UL 668, brass or bronze, 300 psig minimum pressure rating, NPS 2-1/2 hose valve compatible with local fire department requirements, with lugged cap, gasket, and chain. Provide chrome-plated finish.
 - B. Cabinet: Recessed mounting, 18"x18"x8" fire-rated enclosure, solid panel door with continuous steel piano hinge, white baked acrylic enamel finish, type 304 stainless steel, door and frame materials, with appropriate labeling.
- 2.18 AIR VENTS
- A. Air vent shall be UL Listed for Fire Sprinkler Branch line applications per UL subject 2573 – "Automatic Air Release Valves for Fire Protection Service".
 - B. Air vent shall be FM Approved for "Automatic Air Release Valve for Sprinkler Systems".

- C. Furnish and install air release valve(s) at the high point(s) on the fire sprinkler system piping determined by the sprinkler system designer or engineer to assure evacuation of air from the system during and after filling. The automatic air release valve shall consist of a 40 mesh "Y" type strainer connected to an automatic air vent valve. The output of the air vent valve shall be a 1/2" NPT male connection which allows a drain attachment for safely draining inadvertent discharge of water that is inherent in the operation of the automatic air vent. Install drain pipe to appropriate location. The air vent assembly shall be field replaceable without disabling the sprinkler system by the installation of a 1/2" ball valve installed before the Y strainer for isolation purposes. The automatic air release valve shall be mounted in a vertical position and shall require a minimum of 8" of clearance above the fire sprinkler main or branch line piping. The Automatic Air Release Valve shall be a model PAV manufactured by Potter Electric Signal Company LLC or equivalent product meeting these specifications.
- D. Furnish and install a ball valve prior to the "Y" type strainer to isolate the automatic air release valve and strainer from the system for replacement of the automatic air vent or WAGS or strainer maintenance.

3. EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.
 - 1. Flow test is to be performed to meet the criteria established by NFPA 13.
 - 2. Flow test is to be conducted in accordance with NFPA 291.
 - 3. Test is to be performed during a period of ordinary demand for the water system.
 - a. To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.
 - 4. Pitot readings are to be taken at the 2-1/2-inch orifice connection.
 - 5. The pitot reading is to range from 10 to 35 psig.
 - 6. Open additional hydrant outlets as needed to control pitot readings.
 - 7. The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.
- B. Flow Test Data Written Report:
 - 1. Flow data report is to be written in accordance with NFPA 291.
 - 2. Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.
- C. Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.
- D. Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.

- E. Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.2 INSTALLATION OF FIRE-PROTECTION WATER-SERVICE PIPING

- A. Comply with requirements for fire-protection water-service piping in Division 33.

3.3 INSTALLATION

- A. Ream pipe and tube ends. Remove burrs. Bevel, thread or groove plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions. Unions and flanges for servicing and disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points if required.)
- D. Install piping in accordance with NFPA 13 and NFPA 24 as applicable.
 - 1. Grooved Joints: Install in accordance with the manufacturer's latest published installation instructions. Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to (and including) groove. Gasket shall be manufactured by the coupling manufacturer and verified as suitable for the intended service. Contractor shall remove and replace any improperly installed products.
- E. Install seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.
- F. Provide thrust blocks for each change of direction in underground fire service pipe in accordance with NFPA 24.
- G. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient. Place pipe runs to minimize obstruction to other work.
- H. Install piping to conserve building space, and not interfere with use of space and other work. It shall be the primary responsibility of sprinkler contractor to coordinate with other building trades to avoid architectural, structural, mechanical and electrical interference's. All necessary additional sprinklers, piping, and other equipment required to avoid such interferences shall be provided as part of the sprinkler contract without additional compensation after the bid is submitted. However, should a change be made in the work of other contractors or trades from that shown on the drawings which results in additional work for the sprinkler contractor, a reasonable and equitable adjustment in the contract sum may be made.
- I. Sprinkler locations shown on drawings are recommendations only. Sprinkler/standpipe design engineer shall verify and modify locations as necessary to provide a code-compliant, functional system. Sprinkler locations will be subject to review of the Owner and Architect/Engineer during the shop drawing review phase.
- J. Wherever possible, install piping as high as possible so as not to interfere with the work of others. Wherever possible, place piping in concealed spaces above finished ceilings.

- K. Group piping whenever practical at common elevations.
- L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Slope piping and arrange systems to drain at low points.
- M. If it is discovered during installation that any component of the sprinkler system will be exposed to freezing conditions, the contractor shall notify the Architect/Engineer immediately.
- N. Prepare all exposed pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Paint to match finish of adjacent walls surfaces.
- O. Do not penetrate building structural members unless specifically indicated.
- P. Provide sleeves when penetrating footings, fire rated floors and fire rated walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- Q. Die cut screw joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- R. Install valves with stems upright or horizontal, not inverted.
- S. Provide gate, ball or butterfly valves for shut-off or isolating service.
- T. Provide drain valves at main shut-off valves, low points of piping and apparatus.
- U. Pipe main system drain valve and test connection to location outside building. See drawings.
- V. Install equipment in accordance with manufacturer's instructions.
- W. Provide backflow preventer as shown on drawings.
- X. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent fire department connections to allow full swing of fire department wrench handle.
- Y. Install outside alarm gong on building wall in location coordinated with the Architect / Engineer.
- Z. All sprinklers installed in lay-in ceiling tiles shall be centered within the individual ceiling tile. Contractor shall provide all swing joints and/or offsets required to accomplish center locations. Ensure sprinklers are installed level with adjacent ceiling surface.
 - 1. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
 - 2. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.
- AA. Apply masking tape or paper cover to ensure concealed sprinkler head cover plates do not receive field paint finish.

- BB. Flush entire piping system of foreign matter.
- CC. Install pressure gauge on riser or feed main, at each sprinkler test connection, and at top of each standpipe.
- DD. Install sprinkler storage cabinet in penthouse mechanical room. Coordinate location with other trades.
- EE. Install all valves, flow switches, and other accessories in accessible locations. Where these components are located in a concealed area, provide access panels.
- FF. Sprinkler or standpipe piping shall not be installed above any electrical panels, electrical transformers, fire alarm panels, or BAS panels, regardless of distance above.

3.4 FIELD QUALITY CONTROL

- A. Hydrostatically test entire system per NFPA 13 and NFPA 14. Test shall be witnessed by authority having jurisdiction.
- B. Perform a system test with a fire department pumper truck to verify acceptable pressure (typically 100 psig) at the most-remote standpipe hose connection. Connect pumper truck to fire department connection for test. Coordinate with authority having jurisdiction and local fire department.
- C. Note each test in Pipe Pressure Test Log provided in section 21 05 00 of these specifications. Submit test log to Engineer for review before final project closeout. Furnish copy of test log with operation and maintenance data.
- D. The contractor shall furnish and sign copy of Contractor's Material and Test Certificate as provided in NFPA, Section 8-1 (Figure 8-1). Submit certificate to Engineer for review before final project closeout. Furnish copy of certificate with operation and maintenance data.

END OF SECTION

SECTION 22 05 00 - BASIC PLUMBING REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

- A. This section describes Basic Plumbing Requirements required to provide for a complete installation of all plumbing systems for this project. This section shall apply to all other Division 22 specification sections as well as all work shown on the drawings.
- B. Plumbing demolition requirements.
- C. It is the intent of the Plumbing Division of the Specifications that all plumbing work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.
- D. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative.
- E. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.
- F. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.
- G. Note that the words "mechanical" and "plumbing" are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 22.

1.3 DESCRIPTION OF WORK

- A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete plumbing systems required by these specifications and/or shown on the drawings of the contract.
- B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping fixtures, etc. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.

1.4 QUESTIONS OF INTERPRETATION

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- B. The Architect/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of bid.
- B. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of three-dimensional objects. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies should be identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
- C. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of materials or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.
- D. If there is a conflict between manufacturer's recommendations and the Contract Documents, the manufacturer's recommendations shall govern with no additional cost to the Owner.

1.6 PERMITS

- A. All permits, fees, licenses, etc. required for this project shall be obtained by the Contractor.

1.7 QUALITY ASSURANCE

- A. Installers shall have at least 2 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other mechanical sections.
- B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.

- C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.
- D. Quality welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.
- F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.
- G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.8 REFERENCES

- A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:
 - 1. Safety and Health Regulations for Construction.
 - 2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
 - 3. ABMA - American Boiler Manufacturers Association.
 - 4. ACCA - Air Conditioning Contractors of America.
 - 5. ACGIH - American Conference of Governmental Industrial Hygienists.
 - 6. ADC - Air Diffusion Council.
 - 7. AGA - American Gas Association.
 - 8. AIHA - American Industrial Hygiene Association.
 - 9. AMCA - Air Movement and Control Association.
 - 10. ANSI - American National Standards Institute.
 - 11. ARI - Air-Conditioning and Refrigeration Institute.
 - 12. ASA - Acoustical Society of American.
 - 13. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
 - 14. ASME - The American Society of Mechanical Engineers.
 - 15. ASTM - American Society of Testing and Materials.
 - 16. BOCA – Building Officials and Code Administrators International.
 - 17. CABO – Council of American Building Officials.
 - 18. CAGI - Compressed Air and Gas Institute.
 - 19. CTI - Cooling Tower Institute.
 - 20. EJMA - Expansion Joint Manufacturers Association.
 - 21. ETL - Engineering Tests Laboratory.
 - 22. HEI - Heat Exchange Institute.
 - 23. HI - Hydraulic Institute.
 - 24. HYD I - Hydronics Institute.
 - 25. IAPMO – International Association of Plumbing and Mechanical Officials.
 - 26. ICBO - International Conference of Building Officials.
 - 27. ICC – International Code Council.
 - 28. NEBB - National Environmental Balancing Bureau.
 - 29. NEC - National Electrical Code.
 - 30. NEMA - National Electrical Manufacturers Association.
 - 31. NFPA - National Fire Protection Association.

32. NSF - National Sanitation Foundation.
33. SAE - Society of Automatic Engineers.
34. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
35. TEMA - Tubular Exchanger Manufacturers Association.
36. UL - Underwriters Laboratories, Inc.
37. Arkansas Plumbing Code.
38. Arkansas Mechanical Code.
39. Other governing, state, and local codes that apply.

1.9 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and "Special Conditions".
- B. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Mechanical Sections.
 1. Certified performance and data with system operating conditions indicated. All coil, fan, and pump performance data shall be computer generated.
 2. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
 3. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.
 4. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
 5. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.
- C. Coordination drawings
 1. Drawings:
 - a. Provide coordination in determining adequate clearance and space requirements for fire suppression equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.
 - b. Provide coordination drawings indicating new and existing structural components, reflected ceiling layout, fire suppression items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.

- c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.
 - d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.
 - e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.
 - f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.
2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:
- a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.
 - b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.
 - c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.
3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).
- a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.
 - b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):
 - 1) Roof drain leaders
 - 2) Large waste piping
 - 3) Sprinkler mains
 - 4) Equipment located above the ceiling
 - 5) Heating hot water piping
 - 6) Chilled water piping
 - 7) Conduit runs 2 inches and larger
 - 8) Cable tray
 - 9) Bus duct
 - 10) Recessed light fixtures
 - 11) Building wiring or cable trays

- 12) Ceiling heights as shown in contract documents and thickness of system
- 13) Soffits (including framing of supports)
- 14) Access points and clearances required
- 15) Access panels
- 16) Valves
- 17) Dampers
- 18) Coils
- 19) Ductwork
- 20) Fire-rated wall, partition, and floor penetrations
- 21) Steam and condensate piping
- 22) Space allotted for future utilities
- 23) Equipment in mechanical and electrical spaces

c. Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.

4. The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.
5. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.
6. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.
7. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

D. Provide separate shop drawing submittals for the following items:

1. Section 22 05 00 – Basic Plumbing Requirements:
 - a. Plumbing Permits
 - b. Plumbing Licenses
 - c. EPA/ASHRAE 34 Refrigeration Certification (as required)
 - d. Welding certificates
 - e. Warranties
 - f. As-built documents
 - g. Pipe pressure test logs
 - h. Operation and maintenance manuals (electronic copies integrated into BMS)
 - i. Close-out / walk-through documentation

- j. Training seminar documentation
- 2. Section 22 05 19 – Plumbing Meters and Gauges:
 - a. Flow meters
 - b. Calibrated balance valves
 - c. Pressure gauges
 - d. Thermometers
 - e. Pressure/temperature test plugs
- 3. Section 22 05 29 – Plumbing Hangers and Supports:
 - a. Pipe supports, anchors, sleeves, and hangers
 - b. Equipment curbs, supports, and hangers
 - c. Mechanical seals
 - d. Roof curbs and supports
 - e. Fire sealants
- 4. Section 22 05 48 – Plumbing Vibration Controls:
 - a. Vibration Controls
- 5. Section 22 05 53 – Plumbing Identification:
 - a. Plumbing identification materials
 - b. Valve schedule
- 6. Section 22 05 93 – Plumbing Testing and Balancing:
 - a. Pre-balancing conference meeting notes
 - b. Pre-balancing field deficiency report
 - c. Draft TAB report
 - d. Final TAB report
- 7. Section 22 07 16 – Plumbing Equipment Insulation:
 - a. Equipment insulation materials and insulation schedule
- 8. Section 22 07 19 – Plumbing Piping Insulation:
 - a. Pipe Insulation materials and insulation schedule
- 9. Section 22 10 00 – Plumbing Piping:
 - a. Installer factory training and certifications for laboratory waste and vent piping
 - b. Plumbing piping material and fitting schedule
 - c. Plumbing valve material and schedule
 - d. Plumbing pipe accessories
 - e. Plumbing hydrostatic test report(s)
 - f. Domestic water sample test report(s)

10. Section 22 11 19 – Plumbing Specialties:
 - a. Plumbing specialties, cleanouts, plumbing fixture carriers, etc.
 - b. Backflow preventers and backflow preventer tests
11. Section 22 13 23 – Sanitary Waste Interceptors:
 - a. All scheduled sanitary waste interceptors
12. Section 22 13 29 – Sanitary Sewage Pumps:
 - a. All scheduled sanitary sewerage pumps
13. Section 22 14 29 – Sump Pumps:
 - a. All scheduled sump pumps
14. Section 22 21 13 – Plumbing Pumps:
 - a. All scheduled plumbing pumps
15. Section 22 30 00 – Plumbing Equipment:
 - a. All scheduled plumbing equipment
16. Section 22 40 00 – Plumbing Fixtures:
 - a. All scheduled plumbing fixtures and accessories
17. Section 22 61 13 – Compressed Air, Vacuum, and Specialty Gas Systems:
 - a. Installer factory training and certifications
 - b. Specialty gas piping material and fitting schedule
 - c. Specialty gas valve material and schedule
 - d. Specialty gas pipe accessories
 - e. Specialty gas pressure test report(s)
18. Section 22 67 00 – Pure Water Piping:
 - a. Installer factory training and certifications
 - b. Pure water piping material and fitting schedule
 - c. Pure water valves
 - d. Pure water pipe accessories
 - e. Pure water hydrostatic test report(s)
19. Section 22 67 01 – Pure Water Systems:
 - a. Pure water system equipment
20. Section 22 95 00 – Plumbing Commissioning:

a. Plumbing Commissioning Documentation

1.10 SUBSTITUTES

- A. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified.
- B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing. Associated mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted mechanical spaces. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.
- C. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.
- D. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.
- E. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.
- F. Final determination regarding substitutions shall be by the Architect/Engineer.

1.11 WARRANTY

- A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.12 CLOSE OUT AND OPERATION INSTRUCTIONS

- A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.
- B. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.
- C. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.
- D. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.

- E. All tests shall be made after notification to and in the presence of the Owner's representative.
- F. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.
- G. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.
- H. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.
 - 1. Provide instruction seminar, minimum 4 hours each, for each of the following items:
Domestic Water Heater DWH-1 and Water Softener WS-1
- I. At the time of substantial project completion, turn over the prime responsibility for operation of the plumbing equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.
 - 1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.13 RECORD DOCUMENTS

- A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:
 - 1. All plumbing systems as described in the Specifications and/or shown on the drawings.
 - 2. The Plumbing Contractor shall provide the Owner with as-built drawings for mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 22 Section "Plumbing Identification." Indicate actual inverts and horizontal locations of underground piping.
 - 3. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.
 - 4. All items must be dimensioned in horizontal and vertical plans to allow Architect/Engineer to update Building Information Model (BIM) file for Owner.

1.14 MAINTENANCE MANUALS

- A. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.
- B. Provide electronic copies, preferably in Adobe Acrobat Portable Document Format (pdf), of all maintenance manuals to Temperature Control Contractor for use in BMS front-end system. Provide data in file types compatible with BMS.

2. PRODUCTS (NOT APPLICABLE).

3. EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 02 Sections for selective demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components specified under Division 22 and as indicated on the drawings.
 - 1. Controls
 - 2. Demolition related to others areas that must remain on line.
 - 3. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 4. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality. Refer to specific system specification for product information.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

- B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Use proper lifting equipment where size/weight requires handling by such means.
- D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.
- E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.
- F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
- G. Plumbing Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

3.3 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.4 COORDINATION

- A. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- B. Coordinate the plumbing work with work of the different trades so that:
 - 1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
 - 2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
 - 3. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.
- C. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
- D. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.5 PLUMBING INSTALLATIONS

- A. All dimensions and clearances affecting the installation of work shall be verified in the field in relation to established datum, to building openings and to the work of other trades.
- B. The location of all equipment and systems shall be coordinated to preclude interferences with other construction.
- C. Should interferences occur which will necessitate deviations from layout or dimensions shown on the Drawings, the Architect/Engineer and the Owner's representative shall be notified and any changes approved before proceeding with the work.
- D. Arrange for chases, slots, and openings in other building components during progress of construction to allow for mechanical installations.
- E. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum possible headroom. Any plumbing or mechanical items planned to be installed below 8'-0" AFF shall be coordinated with engineer prior to install.
- F. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- G. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
- H. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- I. Install plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- K. Welding, sweating, or brazing operations
 - 1. All cutting, welding, brazing, or sweating operations carried on in the vicinity of, or accessible to, combustible material shall be adequately protected to make certain that a spark or hot slag does not reach the combustible material and start a fire.
 - 2. When it is necessary to do cutting, welding, brazing, or sweating close to wood construction, in pipe shafts, or other locations where combustible materials can not be removed or adequately protected, employ fireproof blankets and proper fire extinguishers. Position another individual nearby to guard against sparks and fire.
 - 3. Whenever combustible material has been exposed to molten metal or hot slag from welding or cutting operations, or spatter from electric arc operations, a guard shall be kept at the place of work for at least one hour after completion to verify that smoldering fires have not been started.

4. Whenever welding or cutting operations are carried on in a vertical shaft or where floor openings exist, a fire guard shall be employed to examine all floors below the point of the welding or cutting operation. The fire guard shall be kept on duty for at least one hour after completion to verify that smoldering fires have not been started.
5. Before any work involving cutting, welding, brazing, or sweating operations is started, consult with the Architect/Engineer as to particular safety precautions to be employed on the work.

3.6 ACCESSIBILITY

- A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.7 LUBRICATION AND TOOLS

- A. Provide a fresh charge of lubricant in accordance with manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.
- B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.8 PIPING SYSTEMS PRESSURE TESTING

- A. The following personnel in the order listed shall be considered acceptable witnesses of all piping pressure testing:
 1. Local Authority Having Jurisdiction
 2. Owner's Representative
 3. Mechanical Engineer / Architect
 4. General Contractor's Foreman
- B. Removal of pressure charge and associated drain down shall also be witnessed.
- C. Mechanical contractor shall provide a minimum of 24-hour notice to at least one of the above listed parties before commencing any piping systems pressure test.
- D. Pressure gauge requirements: Provide recently calibrated gauge with 4" face and a range such that test pressure is between 50% and 100% of gauge range. For example, a gauge with a 15 psig range is acceptable for a 10 psig pressure test, whereas a gauge with a 30 psig range is unacceptable in this application. Gauge resolution shall be suitable for type of testing, system size and test media. Gauge shall have been recently calibrated.
- E. All piping pressurizing equipment (i.e., air compressor) shall be disconnected before test is commenced and shall remain disconnected for the entire duration of the test.
- F. Entire system shall be properly vented before test is commenced.
- G. For specific piping pressure testing requirements and procedures, see applicable piping systems specification sections.

- H. Submit completed "Pipe Pressure Test Log" provided at the end of this Section for each pressure test before final project closeout. Test log shall also be included in operation and maintenance manuals.

NOTE: USE MULTIPLE FORMS IF NECESSARY

3.9 GENERAL CONTRACTOR - MECHANICAL EXTENT OF WORK

A. Access Panels

1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
2. The plans indicate the location of all anticipated access panels. The Division 22 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 22 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the mechanical and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.
3. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
2. The Division 22 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Division 22 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 22 Contractor shall be liable for all associated costs of cutting and patching for mechanical work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly.
8. **All penetrations through the walls, floor, or structure of laboratory spaces, laboratory support spaces, lecture halls, classrooms, conference rooms, corridors or other areas in which relative pressurization relationships are important shall be sealed airtight. Refer to the drawings for additional information regarding rooms in which maintaining pressurization is important.**
9. Repair cut surfaces to match adjacent surfaces.
10. Perform cutting, fitting, and patching of mechanical equipment and materials required to:

- a. Uncover work to provide for installation of ill-timed work.
- b. Remove and replace defective work.
- c. Remove and replace work not conforming to requirements of the Contract Documents.
- d. Remove samples of installed Work as specified for testing.
- e. Install equipment and materials in existing structures.
- f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

- 1. Division 22 Contractor shall perform all excavation and backfilling necessary to install the required mechanical work. Coordinate the work with other excavating and backfilling work in the same area.
- 2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
- 3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to ensure worker safety, proper installation of mechanical work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.
- 4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
- 5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
- 6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
- 7. Final Backfill shall be as follows:
 - a. Outside Building Under Paved Areas: Granular material specified in Division 2.
 - b. Outside Building and Not Under Paved Areas: Clean soil free of vegetable matter and foreign material or crushed limestone. In planted areas backfill to a point 6" below finished grade. Owner will provide topsoil to finished grade.
- 8. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.
- 9. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
- 10. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
- 11. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
- 12. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
- 13. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Mechanical Contractor.

D. Concrete Bases

1. Minimum 4" high concrete housekeeping pads shall be provided under floor mounted mechanical equipment. Concrete inertia pads shall be provided for all base-mounted pumps and air compressors installed above grade.
2. Division 22 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all mechanical equipment bases. The Division 22 Contractor shall be liable for all associated costs to install the mechanical equipment bases upon failure to notify the General Contractor prior to bid submission.
3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.

E. Roof curbs, roof support for mechanical equipment and roof penetrations.

1. Division 22 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 22 Contractor not shown on this plan. The General Contractor shall provide all roof deck mounted equipment and pipe supports, pipe penetrations and cut roof deck for pipe and duct penetrations, unless noted otherwise. The Division 22 Contractor shall furnish all roof curbs and the General Contractor shall install, unless noted otherwise. The Division 22 Contractor shall provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. The Division 22 Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. Division 22 Contractor is to coordinate with the General Contractor all roof curb and roof supports supplied, number, size and location of all roof penetrations. All major roof penetrations are shown on the architectural roof plan. General Contractor shall be notified of all additional roof penetrations provided by the Division 22 Contractor not shown on this plan.

F. Painting

1. The General Contractor is to field paint mechanical equipment and materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. Division 22 Contractor is to coordinate the painting of these items with the General Contractor. The Mechanical Contractor is to provide materials in these areas that are suitable for accepting paint. The clean and preparation of the materials to reach paint is the responsibility of the General Contractor unless noted specifically to be responsibility of the Division 22 Contractor.
2. In concealed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted with one coat of zinc rich paint.
3. In exposed locations, field-fabricated bare iron or steel items required for installation of work under this Division shall have rough or sharp edges removed and shall be painted in accordance with Section 09 91 00.

3.10 ELECTRICAL-PLUMBING EXTENT OF WORK

- A. The responsibility of work specified under Division 22 and 26 is clarified under, Section 22 05 13, "Electrical Requirements for Plumbing Equipment." Division 22 Contractor is to coordinate all electrical requirements prior to ordering powered plumbing equipment.

END OF SECTION

PIPE PRESSURE TEST LOG											
PROJECT:											
BUILDING:						GENERAL CONTRACTOR:					
CLARK ENERSEN PROJECT NUMBER:						MECHANICAL CONTRACTOR:					
TEST INFORMATION						TEST PRESSURE					
TEST DATE	PIPI NG SYS TEM	AREA TESTED	TEST MEDIA (WATER OR AIR)	TEST DURATION (MINUTES)	PRESSURE GAGE NUMBER	INITIAL (PSIG)	FINAL (PSIG)	TESTED BY	WITNESSED BY	PASS / FAIL (P/F)	COMMENTS

ADDITIONAL

COMMENTS:

PRESSURE GAGE INFORMATION											
GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE	GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE

NOTE: USE MULTIPLE FORMS IF NECESSARY

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SECTION 22 05 13 – ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Electrical Requirements for:

1. Motors
2. Starters, Electrical Devices, and Wiring
3. Manual Motor Starters
4. Motor Connections
5. Capacitors
6. Safety Switches

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Electrical components and materials shall be UL labeled and listed.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:
 - a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
 - c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
 - d. ANSI/NEMA Standard MG 1 – Motors and Generators.
 - e. ANSI/NFPA 70 - National Electrical Code.
 - f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
 - g. NEMA Standard 250 – Enclosures for Electrical Equipment.
 - h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and holding

G. Related sections.

1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.3 SUMMARY

- A. This section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment. In addition, this section covers necessary coordination issues between plumbing and electrical disciplines. All plumbing and electrical construction documents must be completely reviewed by the Plumbing and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 MOTORS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
 1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

Motor Service Factor Schedule		
Horsepower:	3600 RPM:	1800 RPM:
1/6 – 1/3	1.35	1.35
1/2	1.25	1.25
3/4	1.25	1.25
1 – 1.25	1.25	1.15
1.5 - 150	1.15	1.15

3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
4. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.

- a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's

- standards to suit each specific application.
 - b. Bearings: Ball or roller bearings with inner and outer shaft seals; re-greasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
 - c. Enclosure Type: Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.
 - d. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.
- 7. Noise rating: "Quiet"
 - 8. Efficiency: **"Premium efficiency"** motors, as defined in NEMA MG 1, most recent edition.
 - 9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
 - 10. All three-phase motors shall be inverter duty type.
 - 11. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.
- a. Provide AEGIS SGR, or approved equivalent, shaft grounding ring/system to divert adverse shaft currents away from the motor bearings. Use AEGIS Colloidal Silver Shaft Coating (PN CS015), or approved equivalent, prior to ring installation. Install coating and ring per manufacturer recommendations.

2.2 STARTERS, ELECTRICAL DEVICES, AND WIRING

- A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections and as outlined as follows:
- B. Motor Connections
 - 1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
 - 2. See Division 26 for the use of lugs for motor connections.
- C. Capacitors
 - 1. Capacitor features shall include:
 - a. Individual unit cells.
 - b. All welded steel housing.
 - c. Each capacitor shall be internally fused.
 - d. Non-flammable synthetic liquid impregnate.
 - e. Craft tissue insulation.
 - f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

D. FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

E. FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

F. MANUAL MOTOR STARTERS

- G. See specification section 26 29 13 – Motor Controllers for requirements.

H. CAPACITORS

1. Capacitor features shall include:
 - a. Individual unit cells.
 - b. All welded steel housing.
 - c. Each capacitor shall be internally fused.
 - d. Non-flammable synthetic liquid impregnate.
 - e. Craft tissue insulation.
 - f. Aluminum foil electrodes
2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

2.3 SAFETY SWITCHES

- A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.

- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.2 CONTRACTOR COORDINATION

- A. It is the responsibility of the Contractor and all Subcontractors to coordinate scope to ensure that all required electrical connections and control connections are provided in accordance with all specification sections. The Architect/Engineer is not responsible for determining which Contractor or Subcontractor will provide particular items.

END OF SECTION

SECTION 22 05 19 – PLUMBING METERS AND GAUGES

1. GENERAL

1.1 SECTION INCLUDES

- A. Water meters.
- B. Pressure gages and pressure gage taps.
- C. Liquid-in-Glass Thermometers
- D. Glass Thermometers
- E. Thermometer wells.
- F. Piping pressure and temperature test plugs.
- G. Sight flow indicators.

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References
- C. Submittals
 - 1. Product Data: For each type of product.
 - a. Include diagrams for power, signal, and control wiring.
- D. Operation and maintenance manuals.
- E. Project record documents
 - 1. Accurately record actual locations of instrumentation.
- F. Delivery, storage, and handling

1.3 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with International Plumbing Code.
- B. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water meters, materials, piping, valves, fittings, backflow preventers, and other items in accordance with NSF/ANSI 61, including Appendix G.

- C. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water faucets, faucet connectors, hoses, supply stops, and other items in accordance with NSF/ANSI 61, including Appendix 9-G.

1.4 ENVIRONMENTAL REQUIREMENTS

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

2. PRODUCTS

2.1 DOMESTIC WATER METER

- A. Construction shall comply with ANSI and AWWA C701 standards as required for domestic water metering applications.
- B. The measuring element shall consist of the transmission coupling, measuring element insert, rotor, inlet and outlet straightening vanes with nose cones, and calibration ring assembly. The register and measuring element shall be designed and constructed so that they may be removed without removing the meter housing from the installation. Meters shall be designed for maximum operating temperature of 120 degrees F and a maximum operating pressure of 150 PSI.
- C. Meter housing shall be cast bronze construction. Nose cone, straightening vanes and rotor shall be thermoplastic construction. Rotor thrust bearings shall be sapphire jewels and rotor bearing pivots shall be 316 stainless steel. Register lid and shroud shall be thermoplastic and bronze and trim shall be stainless steel.
- D. Transmission coupling between measuring element and meter register shall be ceramic magnetic direct drive.
- E. Register shall be a straight-reading odometer-type totalization display, 360 degree test circle with center sweep hand and flow finder to detect leaks. Register gearing shall consist of self-lubricating thermoplastic gears all permanently sealed. Registration for meters less than 6" shall be calibrated for 100,000,000 gallons @ 100 gallons/sweep hand revolution. Registration for meters 6" and larger shall be calibrated for 1,000,000,000 gallons @ 1,000 gallons/sweep hand revolution. Register shall be installed using either tamper detection seal wire screws or TORX tamper resistant seal screws. A tamper resistant calibration plug seal shall also be provided to protect from unauthorized personnel.
- F. Meters shall be provided with an integral 316 stainless steel strainer manufactured and installed into its inlet end complete with a removable cover plate which will permit easy access to the strainer for routine cleaning.
- G. Provide remote readout device if meter is installed greater than 5'-0" above finished floor. Mount remote readout device on wall at 5'-0" above finished floor.
- H. Provide interface with BAS system to allow remote reading of meter usage.
- I. Meter: Points shall be displayed at integral LCD and as outputs to the BAS. Coordinate all requirements with BAS contractor.
- J. Insulation: Removable closed cell insulation, preformed to match meter housing.

- K. See Plumbing Equipment Schedules for specific performance requirements.

2.2 PRESSURE GAUGES

- A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, liquid-filled.
- B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.
- C. Connector: Brass, 1/4-inch NPS.
- D. Scale: White coated aluminum, with permanently etched markings.
- E. Accuracy: Plus or minus 1 percent of range span.
- F. Range: Conform to the following:
 - 1. Vacuum: 30 inches Hg to 15 psi.
 - 2. All fluids: 2 times operating pressure.

2.3 PRESSURE GAUGE ACCESSORIES

- A. Syphon: 1/4-inch NPS straight coil constructed of brass tubing with threads on each end.
- B. Snubber: ASME B40.100, 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure. Provide extension for use on insulated systems.

2.4 THERMOMETERS, GENERAL

- A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.
- B. Scale range: Temperature ranges for services listed as follows:
 - 1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).
 - 2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.5 LIQUID-IN-GLASS THERMOMETERS

- A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.
- B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- C. Tube: Red reading, mercury filled, magnifying lens.

- D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.
- E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.
- F. ASME B40.200

2.6 GLASS THERMOMETERS

- A. Standard: ASME B400.200.
- B. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.
- C. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.
- D. Tube: Red reading, magnifying lens, with non-mercury fluid.
- E. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.
- F. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

2.7 THERMOMETER WELLS

- A. Thermometer Wells: ASME B40.200, Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.9 SIGHT FLOW INDICATORS

- A. Bronze or stainless-steel body, with sight glass and paddle wheel indicator, threaded or flanged ends.
- B. Minimum pressure rating: 150 psig.
- C. Minimum temperature rating: 200 deg F.
- D. End connections for NPS 2 inch and smaller: Threaded.
- E. End Connections for NPS 2-1/2 inch and larger: Flanged.

3. EXECUTION

3.1 GENERAL

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

3.2 METERS

- A. Install where shown on plans and elsewhere as indicated. Provide manufacturer-recommended upstream and downstream straight distances.
- B. General: Install flow meters for piping systems located in accessible locations at most readable position. Maintain manufacturer-recommended minimum upstream and downstream distances.
- C. Window Flow Meters: Install in vertical upward position with impact tube mounted in bushing centered on pipe with 10 pipe diameters upstream and 5 pipe diameters downstream of straight unrestricted piping for 1-1/4 inches and smaller, 20 pipe diameters upstream and 10 pipe diameters downstream for 1-1/2 inches and larger. Calibrate meter after installation in accordance with manufacturer's installation instructions.
- D. Calibrate meter after installation in accordance with manufacturer's installation instructions.
- E. Connect meter to BMS for remote reading capability. Coordinate with controls contractor and provide all necessary interconnections for accurate transmission of data.

3.3 PRESSURE GAUGES

- A. Install pressure gauges in piping tee with pressure gauge valve, located on pipe at most readable position.
- B. Install as shown on plans, and elsewhere as indicated.
- C. Pressure Gauge Ball Valves: Install in piping tee with snubber. Install syphon in lieu of snubber for steam pressure gages.
- D. Pressure Gauge Accessories:
 - 1. Install ball valve between system and pressure gauge.
 - 2. Install in piping tee with snubber.
- E. If applicable, cut rubber nipple on top of pressure gauge per manufacturer recommendations.

3.4 THERMOMETERS

- A. Install thermometers in vertical and tilted positions to allow reading by observer standing on floor.
- B. Install as shown on drawings.
- C. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap. Provide extension on insulated systems. Install in socket extending to center of pipe.

3.5 TEST PLUGS

- A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.6 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gauges to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gauges and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 22 05 29 – PLUMBING HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

- A. Metal pipe hangers and supports
- B. Trapeze pipe hangers.
- C. Metal framing systems.
- D. Thermal hanger-shield inserts.
- E. Fastener systems.
- F. Pipe Stands
- G. Pipe-positioning systems.
- H. Equipment supports.
- I. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 22 05 00 "Basic Plumbing Requirements."
 - 3. Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems" for seismic restraint devices.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.
- C. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

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

1.5 PERFORMANCE REQUIREMENTS

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

1.6 REFERENCES

- A. ANSI/ASME B31.1 – Power Piping.
- B. ANSI/AMSE B31.9 – Building Services Piping.
- C. MSS SP-58 – Pipe Hangers and Supports – Materials, Design, and Manufacture.
- D. MSS SP-89 – Pipe Hangers and Supports – Fabrication and Installation Practices.

1.7 RELATED DOCUMENTS

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

2. PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pre-galvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Hanging Cables with Adjustable Fastener: Gripple Hanging Cable Kit with the following:
 - a. Wire Rope: High tensile steel wire rope, to EN12385 or ASTM A1023/1023M, class A zinc coating; 7 by 7 and/or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi; lengths, diameters, and wire construction to accommodate design loads.
 - b. Adjustable Fastener: one-piece die cast Type ZA2 zinc one-channel body; encasing a series of Type 302 stainless steel springs with serrated self-locking wedges made of sintered steel hardened to minimum 56 Rockwell C, adjustable by means of an integrated mechanism, with safe working load of 120 lb, 240 lb, 550 lb, or 800 lb depending on application., with safety factor of 5:1.

B. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel
3. Hanging Cables with Adjustable Fastener: Gripple Hanging Cable Kit with the following:
 - a. Wire Rope: High tensile steel wire rope, to EN12385 or ASTM A1023/1023M, class A zinc coating; 7 by 7 and/or 7 by 19 cross-sectional construction; having a tensile strength of 256,000 psi; lengths, diameters, and wire construction to accommodate design loads.
 - b. Adjustable Fastener 1: one-piece die cast Type ZA2 zinc one-channel body; encasing a series of Type 302 stainless steel springs with serrated self-locking wedges made of sintered steel hardened to minimum 56 Rockwell C, adjustable by means of an integrated mechanism, with safe working load of 120 lb, 240 lb, 550 lb, or 800 lb, depending on application, with safety factor of 5:1.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips. Example: Gripple Universal Bracket or other approved equivalent.
4. Channels with integrated latching mechanisms: Continuous slotted carbon-steel channel with inturned lips that comes with integrated latching mechanisms on both ends and slotted straps as a hanging member. Example: Gripple Fast Trak system or other approved equivalent.

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

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel

2.4 THERMAL HANGER-SHIELD INSERTS

- A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psig ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 1. Indoor Applications: Zinc-coated steel.
 2. Outdoor Applications: Stainless steel.

2.6 PIPE STANDS

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

B. Compact Pipe Stand:

1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Hardware: Galvanized steel or polycarbonate.
4. Accessories: Protection pads.

C. Low-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
3. Vertical Members: Two galvanized steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: Adjustable horizontal, galvanized steel pipe support channels.
5. Pipe Supports: Roller or Strut clamps or Clevis hanger or Swivel hanger
6. Hardware: Galvanized steel.
7. Accessories: Protection pads.
8. Height: 12 inches above roof

D. High-Profile, Single-Base, Single-Pipe Stand:

1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Single vulcanized rubber or molded polypropylene.
3. Vertical Members: Two galvanized steel, continuous-thread, 1/2-inch rods.
4. Horizontal Member: One adjustable-height, galvanized steel, pipe-support slotted channel or plate.
5. Pipe Supports: Roller or Clevis hanger or Swivel hanger.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch continuous-thread, galvanized-steel rod
8. Height: 36 inches above roof

E. High-Profile, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: Two or more; vulcanized rubber or molded polypropylene
3. Vertical Members: Two or more, galvanized steel channels.
4. Horizontal Members: One or more, adjustable-height, galvanized steel pipe support.
5. Pipe Supports: Roller or Strut clamps or Clevis hanger or Swivel hanger.
6. Hardware: Galvanized steel.
7. Accessories: Protection pads, 1/2-inch continuous-thread rod.
8. Height: 36 inches above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 PIPE-POSITIONING SYSTEMS

A. Description:

1. IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications. Or
2. Pipe positioning clamps with listing reports from ICC-ES or IAPMO-UES. Example: Gripple GC, GCS series or other approved equivalent.

2.8 EQUIPMENT SUPPORTS

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

2.9 MATERIALS

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

3. EXECUTION

3.1 APPLICATION

- A. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size, or install intermediate supports for smaller-diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A36/A36M carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete, after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb.
- G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms, and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

- a. Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
- 2. MSS SP-58, Type 39: Install protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe 4" and larger if pipe is installed on rollers.
- 3. MSS SP-58, Type 40: Install protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe 4" and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- 6. Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.

3.3 INSTALLATION OF EQUIPMENT SUPPORTS

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

3.4 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

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

3.6 PAINTING

- A. Touchup:
 1. Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - a. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
 2. Cleaning and touchup painting of field welds, bolted connections, and abraded, shop-painted areas on miscellaneous metal are specified in Section 09 91 13 "Exterior Painting.", Section 09 91 23 "Interior Painting.", and/or Section 09 96 00 "High-Performance Coatings" depending on application.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finishes.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
- F. Use stainless steel pipe hangers, fiberglass pipe hangers, and/or fiberglass strut systems, as well as stainless steel or corrosion-resistant attachments for hostile environment applications.

- G. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal hanger-shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 - 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 - 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 - 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
 - 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
 - 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.
 - 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment of up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.8 SPECIFIC HANGER AND SUPPORT REQUIREMENTS

A. PIPING SUPPORT SPACING SCHEDULE

PIPING MATERIAL ^a	MAX. HORIZONTAL SPACING (ft.):	MAX. VERTICAL SPACING (ft.):
ABS pipe	4	10 ^c
Aluminum pipe and tubing	10	15
Brass pipe	10	10
Cast-iron pipe ^b	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing ^d	8	10
CPVC pipe or tubing, 1 inch and smaller	3	10 ^c
CPVC pipe or tubing, 1-1/4 inch and larger	4	10 ^c
Lead pipe	Continuous	4
PE-AL-PE pipe or tubing	32 inches	4
PE-RT 1 inch and smaller	32 inches	10 ^c
PE-RT 1-1/4 inch and larger	4	10 ^c
PEX tubing 1 inch and smaller	32 inches	10 ^c
PEX 1-1/4 inch and larger	4	10 ^c
Polypropylene (PP) pipe or tubing, 1 inch and smaller	32 inches	10 ^c
Polypropylene (PP) pipe or tubing, 1-1/4 inch and larger	4	10 ^c
PVC pipe	4	10 ^c
Stainless steel drainage systems	10	10 ^c
Steel pipe ^d	12	15

PIPING SUPPORT SPACING SCHEDULE NOTES:

- a: Refer to International Plumbing Code for additional requirements.
- b: The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
- c: For sizes 2 inches and smaller, a guide shall be installed midway between required vertical supports. Such guides shall prevent pipe movement in a direction perpendicular to the axis of the pipe.

- d: Refer to International Fuel Gas Code for support intervals for fuel gas piping.
- B. Reference manufacturer's recommendations for pure water piping and laboratory waste and vent piping.

END OF SECTION

SECTION 22 05 53 – PLUMBING IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

- A. References
- B. Related Sections
- C. Submittals
 - 1. Product Data: For each type of product indicated.
 - 2. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
 - 3. Valve-numbering scheme.
 - 4. Valve Schedules: For each piping system. Include in operation and maintenance manuals.
- D. Quality Assurance

1.3 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 01 closeout specifications.
- B. Record actual locations of tagged valves.

2. PRODUCTS

2.1 NAMEPLATES

- A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.
- B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.
- B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.
- C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

- A. Reference ASME A13.1 for the following:
 - 1. Color
 - 2. Letter height and label length based on pipe diameter
 - 3. Minimum content requirements
- B. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed and hazard legend where applicable.
- C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service. Provide tape with printing which most accurately indicates the type of service of buried pipe.

3. EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic tape pipe markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.
- D. Identify centralized plumbing equipment with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
- E. Identify pressure reducing valves, backflow preventers, valves, and meters with tags.
- F. Identify control panels and major control components outside panels with plastic nameplates.
- G. Identify valves in main and branch piping with tags.

- H. Tag automatic controls, instruments, and relays. Key to control schematic.
- I. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locate identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.
- J. For division 22 piping systems, install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe. Reference division 33 specifications for tracer wire requirements.

END OF SECTION

SECTION 22 05 93 - TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

1. GENERAL

1.1 SECTION INCLUDES

- A. TAB of domestic water system.
- B. TAB of plumbing equipment:
 - 1. Domestic hot-water in-line circulation pumps.
 - 2. General-duty air compressors.
 - 3. Water Heaters.
- C. Pipe-leakage test verification.
- D. Testing, adjusting, and balancing existing plumbing systems and equipment.

1.2 DEFINITIONS

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

1.3 RELATED SECTIONS

- A. Specification Section 23 05 93 – Testing, Adjusting, and Balancing

1.4 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
- B. Minimum Agenda Items:
 - 1. Coordinate requirements in subparagraphs below with Section 013100 "Project Management and Coordination."
 - 2. The Contract Documents examination report.
 - 3. The TAB plan.
 - 4. Needs for coordination and cooperation of trades and subcontractors.
 - 5. Proposed procedures for documentation and communication flow.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 60 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.
- C. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- D. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- E. Certified TAB reports.
- F. Sample report forms.
- G. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

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

1.7 FIELD CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 PROJECT RECORD DOCUMENTS

1. Record actual locations of all sensors, flow measuring stations, balancing valves and rough setting.

1.9 SCHEDULING/COORDINATION

1. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.
2. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves and fittings. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.
- C. Examine approved submittals for plumbing systems and equipment.
- D. Examine design data, including plumbing system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about plumbing system and equipment controls.
- E. Examine equipment performance data, including pump curves.
 1. Relate performance data to Project conditions and requirements, including pump system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate pump system-effect factors to reduce performance ratings of plumbing equipment when installed under conditions different from the conditions used to rate equipment performance. Compare results with the design data and installed conditions.
- F. Examine system and equipment installations, and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine plumbing equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.
- I. Examine temporary and permanent strainers. Verify that temporary strainer screens used during system cleaning and flushing have been removed and permanent strainers are installed and clean.

- J. Examine control valves for proper installation for their intended function of isolating, throttling, diverting, or mixing fluid flows.
- K. Examine system pumps to ensure absence of entrained air in the suction piping.
- L. Examine operating safety interlocks and controls on plumbing equipment.
- M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

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

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

4. Vacuum System:

- a. Leakage and pressure tests on vacuum system have been satisfactorily completed in accordance with Division 22 requirements.
- b. Piping is complete and all points of inlet are installed.
- c. Systems are flushed, filled, and purged.
- d. Strainers are clean.
- e. Control valves are functioning in accordance with the sequence of operation.
- f. Shutoff and balance valves are 100 percent open.
- g. Vacuum pumps are operational and of proper rotation.
- h. Gauge connections are installed directly at vacuum pump inlet and outlet flanges prior to valves or strainers.
- i. Variable-frequency controllers' startup is complete and safeties are verified.
- j. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

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

3.4 GENERAL PROCEDURES FOR PLUMBING EQUIPMENT

- A. Test, adjust, and balance plumbing equipment indicated on Drawings, including, but not limited to, the following:

1. Motors.
2. Domestic water booster pumps.
3. Domestic water in-line pumps.
4. Domestic water heaters.
5. Sanitary sewage pumps.
6. Drainage pumps.
7. Air compressors.
8. Vacuum pumps.

3.5 PROCEDURES FOR DOMESTIC WATER SYSTEMS

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

3.6 PROCEDURES FOR COMPRESSED-AIR SYSTEMS

- A. Prepare test reports for air compressors, and other equipment. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required equipment flow rates with system design flow rates.
- B. Prepare schematic diagrams of systems' Record drawings piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare compressed-air systems for testing and balancing as follows:
 1. Check remotest point of outlet for adequate pressure.
 2. Check pressure-control valves for proper position.
 3. Locate start-stop and disconnect switches, electrical interlocks, and motor controllers.

4. Verify that motor controllers are equipped with properly sized thermal protection.
- D. Measure and record upstream and downstream pressure of pressure-reducing valves.
- E. Check settings and operation of pressure-reducing valves. Record final settings.
- F. Check settings and operation of each safety valve. Record settings.

3.7 PROCEDURES FOR DOMESTIC HOT-WATER CIRCULATING INLINE PUMP

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

3.8 PROCEDURES FOR MOTORS

- A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.

- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.9 PROCEDURES FOR WATER HEATERS

- A. Gas- and Oil-Fired Water Heaters:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Measure and record pressure drop.
4. Measure and Record relief valve(s) pressure setting.
5. Capacity: Calculate in Btu/h (kW) of heating output.
6. Fuel Consumption: If fuel supply is equipped with flow meter, measure and record consumption.
7. Efficiency: Calculate operating efficiency for comparison to submitted equipment.
8. Fan, motor, and motor controller operating data.

3.10 TOLERANCES

- A. Set plumbing system's flow rates within the following tolerances:

1. Domestic Water Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.
2. Compressed-Air Flow Rate: Plus or minus 5 percent. If design value is less than 10 gpm, within 10 percent.

3.11 PROGRESS REPORTING

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

3.12 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 2. Include a list of instruments used for procedures, along with proof of calibration.
 3. Certify validity and accuracy of field data.
- B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents, including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports vary from indicated values.
14. Test conditions for pump performance forms, including the following:
 - a. Variable-frequency controller settings for variable-flow hydronic systems.
 - b. Settings for pressure controller(s).
 - c. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of distribution systems. Present each system with single-line diagram and include the following:

1. Flow rates.
2. Pipe and valve sizes and locations.
3. Balancing stations.
4. Position of balancing devices.

E. Gas-Fired Water Heaters Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.

- f. Fuel type in input data.
- g. Output capacity in Btu/h.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and speed.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Low-fire fuel input in Btu/h.
- e. High-fire fuel input in Btu/h.
- f. High-temperature-limit setting in deg F.
- g. Operating set point in Btu/h.
- h. Heating value of fuel in Btu/h.

F. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves, and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water-pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump speed.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.

- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

G. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.13 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 22 07 19 – PLUMBING PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size.

1.6 COORDINATION

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

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

1.8 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.9 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

- A. References.
- B. Submittals.
- C. Operation and maintenance manuals.
- D. Project record documents.
- E. Environmental requirements
 - 1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
 - 2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' ('ksi') value: ASTM C335.

Temperature (degrees F)	Maximum 'k' value (btu*in)/(hr*ft ² *deg F))

75	0.23
100	0.24
150	0.25
200	0.28
300	0.34

2. Minimum Service Temperature: -20 degrees F.
3. Maximum Service Temperature: 300 degrees F.
4. Maximum Moisture Absorption: 0.2 percent by volume.

B. Vapor Barrier Jacket

1. ASTM C921, White kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture Vapor Transmission: ASTM E96; 0.02 perm inches.
3. Secure with self sealing longitudinal laps and butt strips.
4. Secure with outward clinch expanding staples and vapor barrier mastic.

C. Tie Wire: 18 gage stainless steel with twisted ends on maximum 12 inch centers.

D. Vapor Barrier Lap Adhesive: MIL-A-3316C, Class 2, Grade A compliant. Compatible with insulation. VOC Limit 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Insulating Cement: ASTM C195; hydraulic setting on mineral wool. VOC Limit 70 g/L (multipurpose construction adhesive).

F. Fibrous Glass Fabric: Cloth, untreated; 9 oz/sq yd weight with 1.0 lb/cu ft density blanket.

G. Indoor Vapor Barrier Finish: Vinyl emulsion type acrylic, compatible with insulation, white color. VOC Limit 50 g/L.

2.2 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.

1. 'k' ((btu*in)/(hr*ft²*deg F)) value: ASTM C177 or C518; 0.21 to 0.27 at 75 degrees F mean temperature rating.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM C209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; <0.10 perm inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

9. Provide documentation indicating that product contains no urea formaldehyde.
 10. Fittings: Pre-fabricated closed cell fittings of like material and thickness as adjacent pipe insulation.
 11. In all exposed finished areas without jacketing, provide white insulation, otherwise use black.
- B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. MIL-A-24179A, Type II, Class I, compliant. Air dried, contact adhesive, compatible with insulation. VOC Limit: 50 g/L or less when calculated according to 40 CFR 59, Subpart D.

2.3 "FIRE WRAP" INSULATION FOR POLYPROPYLENE PIPING

- A. Refer to Section 22 10 00 for polypropylene laboratory waste piping insulation requirements and Section 226700 for polypropylene pure water piping insulation requirements.

2.4 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.
 - a. Minimum Service Temperature: -40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
 - d. Maximum Flame Spread: ASTM E84; 25.
 - e. Maximum Smoke Developed: ASTM E84; 50.
 - f. Thickness: 20 mil.
 - g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.
2. Covering Adhesive Mastic: Compatible with insulation. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).

3. EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Painting of cellular foam insulation is not allowed, provide an approved jacket.**
- C. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.

- D. All exposed insulation shall be installed with an approved jacket.
- E. Insulated pipes conveying fluids below ambient temperature:
1. Provide vapor barrier jackets, factory applied or field applied.
 2. Insulate fittings, joints, flanges, unions, strainers, flexible connectors and valves with molded insulation of like material and thickness as adjacent pipe.
 3. Finish with glass cloth and vapor barrier adhesive.
 4. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 5. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- F. Cellular foam insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:
1. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe.
 2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
 3. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- G. For insulated pipes conveying fluids above ambient temperature:
1. Provide standard jackets, with or without vapor barrier, factory applied or field applied.
 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe.
 3. Finish with glass cloth and adhesive.
 4. For hot piping conveying fluids, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- H. Inserts and Shields:
1. Refer to Section 22 05 29 for additional information.
 2. Application: Piping 1 inch diameter or larger.
 3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 4. Insert Location: Between support shield and piping and under the finish jacket.
 5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
 7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such as Armaflex Armafix Insulation Pipe Hangers, are acceptable.
- I. Finish insulation at supports, protrusions, and interruptions.
- J. For pipe exposed in finished spaces below 8 feet above finished floor, finish with PVC jacket and PVC fitting covers.

- K. For piping exposed in mechanical rooms below 8 feet above finished floor, finish with PVC jacket and PVC fitting covers.
- L. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.
- M. Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.**

3.3 TOLERANCE

- A. Substituted insulation materials, where allowed, shall provide thermal resistance within 10 percent at normal conditions, as materials indicated.

3.4 GLASS FIBER INSULATION SCHEDULE

A. Plumbing Systems

<u>PIPING SYSTEM:</u>	<u>PIPE SIZE:</u>	<u>MIN. THICKNESS:</u>
Domestic Hot Water Supply	1-1/4" & smaller	1"
Domestic Hot Water Supply	1-1/2" & larger	1-1/2"
Domestic Hot Water Recirc	1-1/4" & smaller	1"

3.5 CELLULAR FOAM INSULATION SCHEDULE

A. Plumbing Systems

<u>PIPING SYSTEM:</u>	<u>PIPE SIZE:</u>	<u>MIN. THICKNESS:</u>
Domestic Cold Water	6" & smaller	1"
Laboratory Cold Water	6" & smaller	1"
Soft Cold Water	6" & smaller	1"
Tempered Domestic Water	6" & smaller	1"
Tepid Water to Emergency Fixtures	6" & smaller	None
Refrigerant Piping	6" & smaller	1"
Cold Condensate Drain Piping	6" & smaller	1"
Roof Drain Bodies	All sizes	1"
Roof Drainage Above Grade	All sizes	1"
Plumbing Vents Within 10 Feet of the Exterior Penetration	All sizes	1"
Backflow Preventer indirect Drain Piping in Loading Dock Area	All sizes	1"
Fire Sprinkler System Main Drain and Inspector's Test Valve Drain Within 10 Feet of Building Exterior Penetration	All sizes	1"

END OF SECTION

SECTION 22 10 00 - PLUMBING PIPING

1. GENERAL

1.1 SECTION INCLUDES

- A. Sanitary waste and vent pipe and fittings.
- B. Sump pump discharge pipe and fittings.
- C. Water pipe and fittings.
- D. Storm water pipe and fittings.
- E. Natural gas pipe and fittings.
- F. General compressed air Piping.
- G. Flanges, unions, and couplings.
- H. Dielectric unions.
- I. Valves.
- J. Calibrated balance valves.
- K. Adjustable thermal balancing valve.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

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

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service in accordance with requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of water service.
 - 2. Do not interrupt water service without Construction Manager's written permission.
- B. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service in accordance with requirements indicated:
 - 1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Construction Manager's written permission.

1.6 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
 - 1. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. References
- C. Submittals
- D. Operation and maintenance manuals.
- E. Project record documents
- F. Delivery, storage, and handling

1.7 ENVIRONMENTAL REQUIREMENTS

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

1.8 OPERATION AND MAINTENANCE DATA

- A. Refer to Section 22 05 00.
- B. Siphonic Rainwater Engineered System operation and maintenance manual requirements:
 - 1. The installer will issue 3 bound copies of Operating and Maintenance manuals for the rainwater disposal system to include the following as minimum

- a. Indicating names and address of client, project manager, architect, consulting engineers, contractors and installer.
- b. Description of systems installed.
- c. Planned maintenance requirements.
- d. Details of guarantee.
- e. Calculations.
- f. Isometrics (which have been produced using CAD).

1.9 PERFORMANCE REQUIREMENTS

- A. Perform Work in accordance with International Plumbing Code.
- B. Comply with the International Fuel Gas Code.
- C. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water meters, materials, piping, valves, fittings, backflow preventers, and other items in accordance with NSF/ANSI 61, including Appendix G.
- D. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water faucets, faucet connectors, hoses, supply stops, and other items in accordance with NSF/ANSI 61, including Appendix 9-G.
- E. Seismic Performance: Soil, waste, and vent piping and support and installation to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
 - 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. Component Importance Factor: 1.0
 - 3. Component Amplification Factor: 1.0
 - 4. Component Response Modification Factor: 3.5
- F. Seismic Performance: Natural-gas piping system is to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
 - 1. The term "withstand" means "the piping system will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.5.
 - 3. Component Amplification Factor: 1.0
 - 4. Component Response Modification Factor: 3.5

2. PRODUCTS

2.1 SANITARY WASTE AND VENT PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. At Contractor's option, one of the following systems shall be used:
 - 1. Epoxy Coated Cast Iron Pipe and Fittings: ASTM A74, hub and spigot, service weight.

- a. Approved manufacturers: Charlotte Pipe Edge HP, or approved equivalent.
- b. Coatings shall meet the testing requirements of the EN877 coatings standard.
- c. Pipe and fittings shall be third-party certified to the complete ASTM or CISPI standards.
- d. Pipe and fittings shall have a 10 year warranty.
- e. Joints shall be made by compression gaskets that conform to ASTM C564.

1) Approved manufacturers: Charlotte Pipe Edge HP, or approved equal

- a) Gasket material: Neoprene.
- b) Temperature Range: -30 to 220 deg F.

f. Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.

2. PVC Pipe: ASTM D2665, solid-wall. Cellular core piping is not allowed.

- a. Fittings: PVC, ASTM D2665, made to ASTM D3311, DWV patterns and to fit Schedule 40 pipe.
- b. Joints: Solvent cement, ASTM D2564; and adhesive purple primer, ASTM F656.

2.2 SANITARY WASTE AND VENT PIPING, ABOVE GRADE (PLENUM AREAS)

A. At Contractor's option, one of the following systems shall be used:

1. Epoxy Coated Cast Iron Pipe and Fittings: ASTM A888 or CISPI 301, hubless, service weight.

- a. Approved manufacturers: Charlotte Pipe Edge HP, or approved equivalent.
- b. Coatings shall meet the testing requirements of the EN877 coatings standard.
- c. Pipe and fittings shall be third-party certified to the complete ASTM or CISPI standards.
- d. Pipe and fittings shall have a 10 year warranty.
- e. Couplings:

1) Approved Manufacturer: Charlotte Edge HP Heavy-duty Couplings, or approved equivalent.

2) Certifications and Standards:

- a) Meets ASTM C 1540 excluding gasket material
- b) Meets CSA B 602
- c) IAPMO and CSA Listed

3) Materials Specification

- a) Screw: Type 305 AISI Stainless 3/8"
- b) Shield: Type 304 AISI Stainless steel, corrugated. Shield thickness 008".
- c) Bands: Type 304 AISI Stainless Steel
- d) Gasket: Primary Elastomeric Polymer is EPDM
- e) Screw housing: Type 304 AISI stainless steel

4) Number of bands (by size):

- a) 1-1/2 – 4": 4
- b) 5-15": 6

2. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

- a. Fittings: Socket type (ASTM D 2665).
- b. Joints: Adhesive Primer (ASTM F 656) and Solvent Cement (ASTM D 2564).
- c. When installed within an air plenum, the pipe, fittings, adhesives and pipe insulation shall have a flame spread index of 25 or less and a smoke developed index of 50 or less when tested as a composite assembly, or fully enclosed within one of the following exceptions 5.1 – 5.3 listed in IMC 602.2.1.

2.3 SANITARY WASTE AND VENT PIPING, ABOVE GRADE (NON-PLENUM AREAS)

A. At Contractor's option, one of the following systems shall be used:

1. Epoxy Coated Cast Iron Pipe and Fittings: ASTM A888 or CISPI 301, hubless, service weight.
 - a. Approved manufacturers: Charlotte Pipe Edge HP, or approved equivalent.
 - b. Coatings shall meet the testing requirements of the EN877 coatings standard.
 - c. Pipe and fittings shall be third-party certified to the complete ASTM or CISPI standards.
 - d. Pipe and fittings shall have a 10 year warranty.
 - e. Couplings:
 - 1) Approved Manufacturer: Charlotte Edge HP Heavy-duty Couplings, or approved equivalent.
 - 2) Certifications and Standards:
 - a) Meets ASTM C 1540 excluding gasket material
 - b) Meets CSA B 602
 - c) IAPMO and CSA Listed
 - 3) Materials Specification
 - a) Screw: Type 305 AISI Stainless 3/8"
 - b) Shield: Type 304 AISI Stainless steel, corrugated. Shield thickness 008".
 - c) Bands: Type 304 AISI Stainless Steel
 - d) Gasket: Primary Elastomeric Polymer is EPDM
 - e) Screw housing: Type 304 AISI stainless steel
 - 4) Number of bands (by size):
 - a) 1-1/2 – 4": 4
 - b) 5-15": 6
2. PVC Pipe (non-return plenum areas): ASTM D2665, solid-wall. Cellular core piping is not allowed. (Used only for fluid streams less than 120 Deg. F)

- a. Fittings: PVC, ASTM D2665, made to ASTM D3311, DWV patterns and to fit Schedule 40 pipe.
- b. Joints: Solvent cement, ASTM D2564; and adhesive purple primer, ASTM F656.

2.4 SUMP PUMP DISCHARGE PIPING

A. Copper Tubing: ASTM B88, Type L, hard drawn.

- 1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
- 2. Joints: AWS A5.8, BCuP silver braze.
 - a. Minimum 15% silver bearing filler material for copper-to-copper joints.
 - b. Minimum 45% silver bearing filler material for dissimilar metal joints.

2.5 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Copper Tubing: ASTM B88, Type K, hard drawn.

- 1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
- 2. Joints: AWS A5.8, BCuP silver braze.
 - a. Minimum 15% silver bearing filler material for copper-to-copper joints.
 - b. Minimum 45% silver bearing filler material for dissimilar metal joints.

B. Ductile Iron (3" and larger)

- 1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end. Pipe and fittings shall have ANSI/AWWA C104/A21.4, cement-mortar lining for ductile-iron pipe and fittings for water. Pipe and fittings shall also have ANSI/AWWA C105/A21.5, polyethylene encasement for ductile iron pipe systems. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.
 - a. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern. Provide manufacturer's restraining joint system equivalent to U.S. Pipe HP-Lok. Ductile Iron (3" and larger)
 - b. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- 2. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated. Pipe and fittings shall have ANSI/AWWA C104/A21.4, cement-mortar lining for ductile-iron pipe and fittings for water. Pipe and fittings shall also have ANSI/AWWA C105/A21.5, polyethylene encasement for ductile iron pipe systems.
 - a. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern. Provide manufacturer's restraining joint system equivalent to U.S. Pipe HP-Lok.
 - b. Gaskets: AWWA C111, rubber.

2.6 WATER PIPING, ABOVE GRADE

A. Copper Tubing: ASTM B88, Type L, hard drawn.

1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze.
2. Joints: Lead Free, ASTM B32, Alloy B solder, for piping 1-1/2" and smaller. AWS A5.8, BCuP silver braze, for piping 2" and larger.
 - a. Minimum 15% silver bearing filler material for copper-to-copper joints.
 - b. Minimum 45% silver bearing filler material for dissimilar metal joints.
3. Press-Connect Joints (4" and smaller):
 - a. Fittings: Fittings shall be Viega, Apollo, Nibco or approved equivalent. Fittings 1/2-inch thru 4-inch shall conform to ANSI B16.18 bronze or B16.22 copper and NSF/ANSI 61-G. Fittings 1/2-inch thru 2-inch shall be double press with Smart Connect feature and have either an EPDM, FKM or HNBR sealing element depending upon manufacturer-approved application guidelines. Fittings 2-1/2-inch thru 4-inch shall have a 420 stainless steel grip ring, separator ring, sealing element and Smart Connect feature. Sealing elements shall be verified for the intended use.
 - 1) Only fittings that conform to NSF 61-pw with EPDM sealing element shall be installed in potable water systems.
 - 2) All fittings shall be from the same manufacturer.

2.7 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. At Contractor's option, one of the following systems shall be used:

1. Cast Iron Pipe: ASTM A74, hub-and-spigot, service weight, bearing CISPI trademark.
 - a. Fittings: Cast iron, ASTM A74, service weight, bearing CISPI trademark.
 - b. Joints: ASTM C564 neoprene gasket system equivalent to Tyler Pipe Ty-Seal.
2. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - a. Fittings: Socket type (ASTM D 2665).
 - b. Joints: Adhesive Primer (ASTM F 656) and Solvent Cement (ASTM D 2564).

2.8 STORM WATER PIPING, ABOVE GRADE (PLENUM AREAS)

A. At Contractor's option, one of the following systems shall be used:

1. Cast Iron Pipe: ASTM A888 and/or CISPI 301, hubless, service weight, bearing CISPI trademark.
 - a. Fittings: Cast iron, ASTM A888 or CISPI 301, service weight, bearing CISPI trademark.
 - b. Joints: ASTM C-1540, neoprene gaskets and heavy-duty stainless steel 4-band clamp-and-shield assemblies.
2. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

- a. Fittings: Socket type (ASTM D 2665).
- b. Joints: Adhesive Primer (ASTM F 656) and Solvent Cement (ASTM D 2564).
- c. When installed within an air plenum, the pipe, fittings, adhesives and pipe insulation shall be plenum rated, have a flame spread index of 25 or less and a smoke developed index of 50 or less when tested as a composite assembly, or fully enclosed within one of the following exceptions 5.1 – 5.3 listed in IMC 602.2.1.

2.9 STORM WATER PIPING, ABOVE GRADE (NON-PLENUM AREAS)

A. At Contractor's option, one of the following systems shall be used:

- 1. Cast Iron Pipe: ASTM A888 and/or CISPI 301, hubless, service weight, bearing CISPI trademark.
 - a. Fittings: Cast iron, ASTM A888 or CISPI 301, service weight, bearing CISPI trademark.
 - b. Joints: ASTM C-1540, neoprene gaskets and heavy-duty stainless steel 4-band clamp-and-shield assemblies.
- 2. Solid-Wall PVC Pipe (non-plenum areas): ASTM D 2665, drain, waste, and vent.
 - a. Fittings: Socket type (ASTM D 2665).
 - b. Joints: Adhesive Primer (ASTM F 656) and Solvent Cement (ASTM D 2564).

2.10 NATURAL GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, 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 A234/A234M for butt welding and socket welding.
- 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
- 4. Steel Press Fittings: Viega Megapress G, ASTM F3226, ASME B31, carbon steel cold press fitting system designed for fuel gas systems.

B. Drawn-Temper Copper Tube: Comply with ASTM B837, Type G.

- 1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
- 2. Bronze Flanges and Flanged Fittings: ASME B16.24, Class 150.
 - a. Gasket Material: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.
 - b. Bolts and Nuts: ASME B18.2.1, carbon steel or stainless steel.

2.11 COMPRESSED AIR PIPING

A. Copper piping, ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed

B. Wrought-Copper Fittings: ASME B16.22

2.12 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 Inches and Under:

1. Ferrous pipe: 150 psig malleable iron threaded unions.
2. Copper tube and pipe: 150 psig bronze unions with soldered joints.

B. Pipe Size Over 2 Inches:

1. Ferrous pipe: 150 psig forged steel slip-on flanges; 1/16 inch thick preformed neoprene gaskets.
2. Copper tube and pipe: 150 psig slip-on bronze flanges; 1/16 inch thick preformed neoprene gaskets.

C. Flanges, unions, and couplings used in potable water systems shall be lead-free construction. Refer to paragraph 1.9 PERFORMANCE REQUIREMENTS.

2.13 DIELECTRIC NIPPLE

A. Standard: IAPMO PS 66.

B. Electroplated steel nipple complying with ASTM F1545.

C. Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F.

D. End Connections: Male threaded.

E. Lining: Inert and noncorrosive, propylene.

F. Dielectric nipples used in potable water systems shall be lead-free construction. Refer to paragraph 1.9 PERFORMANCE REQUIREMENTS.

2.14 SWING CHECK VALVES

A. Up to and including 2 Inches: Bronze swing disc, 125 psig working pressure.

B. Over 2 Inches: Cast iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

C. Check valves used in potable water systems shall be lead-free construction. Refer to paragraph 1.9 PERFORMANCE REQUIREMENTS.

2.15 BALL VALVES

A. Up to and including 4 inches: Bronze two piece body, chrome plated steel full-port ball, teflon seats and stuffing box ring, lever handle.

B. Ball valves used in potable water systems shall be lead-free construction. Refer to paragraph 1.9 PERFORMANCE REQUIREMENTS.

2.16 BUTTERFLY VALVES

- A. 3 Inches and larger:
 - 1. Standard: MSS SP-67, Type I.
 - 2. CWP Rating: 200 psig.
 - 3. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - 4. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - 5. Seat: EPDM or NBR.
 - 6. Stem: One- or two-piece stainless steel.
 - 7. Disc: Aluminum bronze or neoprene coated ductile iron.
 - 8. Valves used in potable water systems shall be lead-free construction. Refer to paragraph 1.3 REGULATORY REQUIREMENTS.

2.17 STRAINERS

- A. Size 2 inch and Under: Screwed bronze body for 250 psig working pressure, Y pattern with 20-mesh stainless steel perforated screen.
- B. Size 2-1/2 inch and larger: Flanged cast iron body for 175 psig working pressure, Y pattern with 3/64 inch stainless steel perforated screen.
- C. Strainers used in potable water systems shall be lead-free construction. Refer to paragraph 1.9 PERFORMANCE REQUIREMENTS.

2.18 GAS VALVES

- A. Gas Cocks 2 Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends.
- B. Gas Cocks 2-1/2 Inch and Larger: MSS SP-78; 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends.
- C. Solenoid Valves: Aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coils; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.
- D. Gas Line Pressure Regulators: Single stage, steel or aluminum jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow indicated.

2.19 CALIBRATED BALANCE VALVES

- A. Pre-Set Balance Feature. Valves to be designed to allow Installing Contractor to pre-set balance points for proportional system balance prior to system start-up in accordance with scheduled flow rates.

- B. Valve Design and Construction. All valves shall have a calibrated orifice or venturi section, two 1/4" threaded pressure tap ports with integral seals, and memory stop to retain the set position. Valves should be rated for 125 psig working pressure and 250 Deg. F maximum operating temperature.
- C. Valves used in potable water systems shall be lead-free construction. Refer to paragraph 1.9 PERFORMANCE REQUIREMENTS.
- D. Valves shall be selected based on flowrate, not on pipe size dimensions.
- E. Preformed Insulation. All valves to be provided with molded insulation to permit access for balance and read-out.
- F. Design Pressure/Temperature.
 - 1. 1/2" - 3" NPT connections 300 psig to 250 deg. F.
 - 2. 1/2" and 3/4" Sweat connections 200 psig at 250 deg. F.
 - 3. 4" flanged connections 125 psig at 250 deg. F.
- G. Calibrated balance valves to be ITT Bell and Gossett Model CB or equivalent.

2.20 DRAIN VALVES

- A. Equipped with hose adaptor fitting and cap.

3. EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

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

3.3 INSTALLATION

- A. General:
 - 1. Install in accordance with manufacturer's instructions.
 - 2. Provide non-conducting dielectric connections wherever jointing dissimilar metals. Only use dielectric nipples. Dielectric unions are not allowed unless approved by engineer of record.
 - 3. Route piping in orderly manner and maintain gradient.
 - 4. Install piping to conserve building space and not interfere with use of space.
 - 5. Group piping whenever practical at common elevations.

6. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
7. Vent pipes shall extend minimum 12" above finish roof line or as required by code.
8. Provide clearance for installation of insulation and access to valves and fittings.
9. **Unless otherwise noted, e.g. fire-wrapped, do not install PVC pipe and fittings in return air plenums.**
10. Provide access where valves and fittings are not exposed.
11. Establish elevations of buried sanitary and storm piping outside the building to ensure not less than 3 ft of cover.
12. Establish elevations of buried water piping outside the building to ensure not less than 5 ft of cover.
13. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
14. Prepare pipe, fittings, supports, and accessories not prefinished, ready for finish painting.
15. Install bell and spigot pipe with bell end upstream.
16. Install valves with stems upright or horizontal, not inverted.
17. Extend chains on valves with chainwheel operators down to maximum 5-feet above finished floor.
18. Install strainers in horizontal pipe or in vertical pipe such that flow is downward. Do not install strainers in vertical pipe with flow upward.
19. Install cast iron piping system according to CISPI Handbook.
20. Install copper tubing under building slab according to CDA's "Copper Tube Handbook." Install ball valve directly upstream of each floor slab penetration.
21. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.

3.4 APPLICATION

A. General:

1. Install unions downstream of valves at equipment or apparatus connections.
2. Install valves for shut-off and to isolate equipment, part of systems, vertical risers, and at every floor off of risers, even if not shown on plan.
3. Install ball valves for throttling, bypass, or manual flow control services.
4. Provide spring loaded check valves on discharge of water pumps.
5. Provide ball valve as flow control valve in water recirculating systems where indicated. Balance flow to maintain hot water at all plumbing fixtures.

B. Natural Gas Piping:

1. Provide plug valves in natural gas systems for shut-off service.
2. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
3. Outdoor Piping:
 - a. Paint piping, fittings, and equipment that are exposed to view from grade with factory-applied paint or protective coating. This includes but is not limited to: exterior metal piping, valves, service regulators, service meters and meter bars, and piping specialties.
 - 1) Alkyd System: MPI EXT 5.1D.
 - a) Prime Coat: Alkyd anticorrosive metal primer.

- b) Intermediate Coat: Exterior alkyd enamel matching topcoat.
- c) Topcoat: Exterior alkyd enamel semigloss
- d) Color: By Architect

3.5 ERECTION TOLERANCES

- A. Establish invert elevations, slopes for drainage to 1/8 inch per foot minimum or as indicated on drawings. Maintain gradients.
- B. Slope water piping and arrange to drain at low points.

3.6 PLUMBING PIPING PRESSURE TESTING

- A. Test for leaks and defects all new plumbing piping systems and parts of existing systems, which have been altered, extended or repaired. Submit copy of Pipe Pressure Test Log provided in section 22 05 00 for each section of piping tested. Refer to International Plumbing Code for general pipe pressure testing requirements (i.e., test pressure gauges, inspections, etc.).
- B. Leave uncovered and unconcealed all new, altered, extended, or replaced piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.
- C. Repair all leaks and defects using new materials and retest all plumbing systems until satisfactory results are obtained.
- D. Natural Gas Piping System.
 - a. Test in accordance with International Fuel Gas Code, NFPA 54, and local utility requirements.
- E. Compressed Air Piping Leak Test: Cap and fill piping system with oil-free dry air or gaseous nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate the test source and let stand for four hours to equalize temperature. Refill system, if necessary, to test pressure; hold for two hours with no drop in system pressure.
- F. Repair or replace compressed air piping as required to eliminate leaks, and retest to demonstrate compliance.

3.7 DISINFECTION OF WATER PIPING SYSTEMS

- 1. After water systems have been pressure tested and flushed, each system (including distribution system to building) shall be cleaned and disinfected per AWWA C651. Note that procedures shall require two (2) consecutive sets of acceptable samples taken at least 24 hours apart.
- 2. Take samples no sooner than 24 hours after flushing, from outlets and from water entry per AWWA 651, and analyze in accordance with AWWA C651.
- 3. Samples shall be subject to bacteriological testing by a recognized 3rd party testing agency. Send test reports to Owner for review. If unsatisfactory bacteriological results are found, the system shall be disinfected and retested again until satisfactory results are obtained.

3.8 SERVICE CONNECTIONS

- A. Provide new sanitary and storm sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Provide new water service complete with approved backflow preventer and water meter with by-pass valves.
 - 1. Provide sleeve in wall for service main and seal at wall/floor with mechanical sleeve seals. Anchor service main inside to concrete wall/floor.
- C. Provide new gas service complete with gas meter and regulators.

END OF SECTION

SECTION 22 11 19 - PLUMBING SPECIALTIES

1. GENERAL

1.1 SECTION INCLUDES

- A. Reduced Pressure Principle Backflow preventers.
- B. Double Check Backflow Preventers.
- C. Expansion tanks.
- D. Cleanouts.
- E. Water hammer arresters.
- F. Floor drains and floor sinks.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Test and inspection reports.

1.4 CLOSEOUT SUBMITTALS

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

1.5 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References
- C. Submittals
- D. Operation and maintenance manuals.
- E. Project record documents
- F. Delivery, storage, and handling

1.6 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with International Plumbing Code.
- B. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water meters, materials, piping, valves, fittings, backflow preventers, and other items in accordance with NSF/ANSI 61, including Appendix G.
- C. Provide lead-free materials (0.25% lead by weighted average) for applicable potable water faucets, faucet connectors, hoses, supply stops, and other items in accordance with NSF/ANSI 61, including Appendix 9-G.

2. PRODUCTS

2.1 REDUCED-PRESSURE-PRINCIPLE BACKFLOW PREVENTERS

- A. Standard: ASSE 1013.
- B. Operation: Continuous-pressure applications.
- C. Body: Bronze for 2" and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for 2-1/2" and larger.
- D. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- E. Accessories:
 - 1. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
 - 2. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- F. Manufacturers: Watts or Febco.

2.2 DOUBLE-CHECK BACKFLOW-PREVENTION ASSEMBLIES:

- A. Standard: ASSE 1015.
- B. Operation: Continuous-pressure applications, unless otherwise indicated.
- C. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
- D. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- E. Accessories:
 - 1. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
- F. Manufacturers: Watts or Febco.

2.3 DIAPHRAGM-TYPE EXPANSION TANKS

- A. 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, with flexible butyl rubber bladder sealed into tank and steel support stand.
- B. Accessories: Pressure gauge and air-charging fitting, tank drain.
- C. Manufacturer: Taco Series CA or equivalent.

2.4 CLEANOUTS

- A. Exterior Surfaced Areas: Round or Square cast nickel bronze access frame and non-skid cover.
- B. Interior Finished Floor Areas: cast iron body and frame, nickel bronze top to accommodate the following floor finishes as required:
 - 1. Exposed rim type with recess to receive tarrazzo or resilient floor finish.
 - 2. Exposed finish type with standard mill finish.
 - 3. Exposed flush type with standard scored or abrasive finish.
 - 4. Concealed undercarpet flush type with mill finish and carpet marker.
- C. Interior Finished Wall Areas: Line type with cast iron body and round gasket cover and round stainless steel access cover secured with machine screw.
- D. Interior Unfinished Accessible Areas: Caulked or threaded type.

2.5 WATER HAMMER ARRESTERS

- A. Standard: ASSE 1010 or PDI-WH 201.
- B. Type: Metal bellows or copper tube with piston.
- C. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F. Size per manufacturer recommendations.

2.6 FLOOR DRAINS AND FLOOR SINKS

- A. Refer to Plumbing Fixture Schedule for required product information.
- B. Barrier-type trap seal protection device: SureSeal or equivalent waterless inline drain trap seal. HDPE (High Density Poly Ethylene) housing with heavy duty silicone diaphragm and soft EPDM rubber sealing gasket. Floor rating ASSE 1072 AF GW.

2.7 OTHER SPECIALTIES

- A. Refer to Plumbing Fixture Schedule for required product information.

3. EXECUTION

3.1 PREPARATION

- A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.2 INSTALLATION

A. All Plumbing Specialties:

- 1. Install in accordance with manufacturer's instructions.

B. Backflow Preventers:

- 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to either building exterior or floor drain (coordinate with plans). Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
- 2. If equipped with a relief valve, pipe relief from backflow preventers to nearest drain. Piping diameter of drain piping shall match outlet diameter of air gap fitting.
- 3. Provide final certification for all testable backflow preventers, after installation, by certified cross connection device tester. Submit copy of successful test to AHJ.

C. Backflow Preventers:

- 1. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to either building exterior or floor drain (coordinate with plans). Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
- 2. If equipped with a relief valve, pipe relief from backflow preventers to nearest drain. Piping diameter of drain piping shall match outlet diameter of air gap fitting.
- 3. Provide final certification for all testable backflow preventers, after installation, by certified cross connection device tester. Submit copy of successful test to AHJ.

D. Cleanouts:

- 1. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- 2. Encase exterior cleanouts in concrete flush with grade.

E. Water Hammer Arrestors:

- 1. Install water hammer arrestors complete with accessible isolation valve according to PDI-WH 201 and as shown on drawings.

F. Floor Drains / Floor Sinks:

- 1. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
- 2. Position floor drains for easy access and maintenance.

3. Unless dimensioned on drawings, location of drains shown on plans are approximate. Installing contractor shall be responsible for coordinating final location with other trades to ensure proper coordination with other building elements including but not limited to: structural members (above/below grade), owner-furnished equipment, walls, and bathroom partitions. Upon identifying a coordination conflict, the contractor shall notify the Engineer of Record by way of RFI with suggested location for drain and obtain approval of new location. No additional compensation shall be provided by Owner for lack of coordination.
4. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
5. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
6. Install barrier-type trap seal protection device in all floor drains and sinks, unless noted otherwise on plans.

3.3 TESTING

- A. Test and certify all backflow preventers for proper operation. Testing agent shall be Grade VI Water Operator.
 1. Test shall be completed within 30 days of installation or Substantial Completion, whichever is later.

END OF SECTION

SECTION 22 14 29 - SUMP PUMPS

1. GENERAL

1.1 SECTION INCLUDES

- A. Sump Pumps
- B. Sump Pump Basins

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Sump pumps - submersible.
 - 2. Sump pumps - wet-pit volute.
 - 3. Oil-sensing sump pumps and controllers.
 - 4. Sump pumps - pedestal.
 - 5. Sump-pump basins and basin covers.
 - 6. Packaged drainage-pump units - submersible.
- B. Product Data Submittals: For each product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles.
 - 2. Rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Shop Drawings:
 - 1. Include plans, elevations, sections, and mounting/[attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls.
 - 1. Indicate actual installed items by marking submittals with an arrow or box.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with manufacturer's written instructions for handling.

1.5 WARRANTY

- A. Manufacturer Warranty: Manufacturer agrees to repair or replace sump pumps that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: 1 year from date of Substantial Completion.

1.6 SOURCE LIMITATIONS

- A. Obtain each type of sump pump from single source from single manufacturer.

1.7 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.8 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.

2. PRODUCTS

2.1 SUMP PUMPS (ELEVATOR(S))

- A. Manufacturer: Zoeller (Basis of Design), Gould, Liberty, Stancor or approved equivalent.
- B. Refer to Sump Pump Schedule on drawings for additionally required product information.
- C. Pump motor shall be hermetically sealed, submersible-type operating in a high-quality dielectric oil for cooling the windings and for lubrication of the motor bearings and ceramic-carbon shaft seal. Single phase motor shall have internal automatic resetting, thermal overload protection. Construction shall be of cast iron with 100% baked-on, powder coated epoxy finish for corrosion-resistance and longer casting durability. All fasteners and external metal parts shall be of stainless steel. Impeller shall be of vortex non-clog design.
 - 1. Pump shall have a permanent split capacitor motor. Motor housing shall be cast iron. The impeller shall be glass reinforced thermoplastic.
- D. The Oil Smart Pump Switch shall be an industrial grade switch with internal 20 amp relay and 304 stainless steel sensor probes used to control water pumps in elevator, utility, marine and industrial sump applications. Installation shall prevent oil and or hydrocarbons from being inadvertently pumped into the environment.
 - 1. Provide with 20' (6 m) cord with piggyback plug.
- E. 115 Volt Piggyback Power Plug.
- F. Oil Smart Alarm shall alert residents or maintenance personnel of liquid level problems. High Oil and High Water Level Lights and standard Remote Dry Contacts (SCADA Monitoring System).

1. Alarm System with High Liquid Audible Alarm (71db @ 2' [0.6 m]), Red Beacon, Oil Present - Yellow Light and Water Present - White Light. Built with Oil Smart® technology.
- G. Liquid Smart Sensor incorporates both an electro-optic and Oil Smart Sensor all in one encapsulated unit. Differentiates and indicates the presence of oil and or water under high water condition.
- H. Oil Smart Simplex Control Panel - Built with Oil Smart® technology. Shall control pump and alert residents or maintenance personnel of liquid level problems. High Oil and High Water Level Lights and standard Remote Dry Contacts (SCADA Monitoring System).

3. EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 312000 "Earth Moving."

3.2 COORDINATION

- A. Coordinate sump hole with other trades and elevator provider. Best location is one of the rear corners of the hoistway away from the counterweight and any other elevator components.
- B. See plans for location of oil smart alarm. Coordinate final location with Owner. Unit shall not be located in the hoistway..

3.3 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.4 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.5 CONNECTIONS

- A. Coordinate pump installations and specialty arrangements with Drawings and with requirements specified in piping systems.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Perform each visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Pumps and controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 22 21 23 - PLUMBING PUMPS

1. GENERAL

1.1 SECTION INCLUDES

- A. In-line wet rotor circulation pumps for potable water systems.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.4 CLOSEOUT SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written instructions for handling.

1.6 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

- A. References.
 - 1. HI - Hydraulic Institute.
 - 2. ANSI - American National Standards Institute.
 - 3. OSHA - Occupational Safety & Health Administration.
 - 4. ASHRAE – American Society of Heating, Refrigeration and Air-Conditioning Engineers.
 - 5. NEMA - National Electrical Manufacturers Association.

6. UL - Underwriters Laboratories.
7. ETL - Electrical Testing Laboratories.
8. CSA - Canadian Standards Association.
9. NEC - National Electric Codes.
10. ISO - International Standards Organization.
11. IEC - International Electrotechnical Commission.
12. ASME – American Society of Mechanical Engineers.

B. Performance requirements.

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.
2. UL Compliance: UL 778 for motor-operated water pumps.
3. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

C. Submittals.

1. Submit each item in this article according to the Conditions of the Contract, Division 1 Specification Sections, and requirements outlines in Specification Section 22 05 00.
2. Submit manufacturer's installation instructions under provisions of General Conditions and Division 1.
 - a. Operation and Maintenance Data: Include installation instructions, assembly views, and replacement parts lists.
 - b. Under provisions of commissioning documentation, testing of pumps, as well as training of owner's operation and maintenance personnel may be required in cooperation with the commissioning consultant.
3. Product Data including published performance curves and rated capacities of selected model, shipping weights, furnished specialties, and accessories. Indicate pump's operating point on curves.
4. Complete Package information:
 - a. System summary sheet (where applicable)
 - b. Shop drawing indicating dimensions, required clearances and location and size of each field connection
 - c. Power and control wiring diagram
 - d. System profile analysis including pump curves, system curve, and variable speed pump curves (where applicable)
 - e. Pump data sheets - Rated capacities of selected models and indication of pump's operating point on curves.
 - f. Submittals on furnished specialties and accessories
 - g. Submittals must be specific to this project. Generic submittals will not be accepted
 - h. Warranty information.
5. Hanging and support requirements should follow the recommendation.

D. Qualifications.

E. Delivery, storage and handling.

1. Deliver materials to the site in such a manner as to protect the materials from shipping and handling damage. Provide materials on factory provided shipping skids and lifting lugs if required for handling. Materials which could be damaged by the elements should be packaged in such a manner that they could withstand short-term exposure during transportation.
2. Store materials in clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage.
3. Use all means necessary to protect equipment before, during, and after installation.
4. All scratched, dented, and otherwise damaged units shall be repaired or replaced as directed by the Engineer.

1.7 PERFORMANCE REQUIREMENTS

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

2. PRODUCTS

2.1 IN-LINE WET ROTOR CIRCULATION PUMPS FOR POTABLE WATER SYSTEMS

- A. See Plumbing Pumps Schedule on drawings for performance requirements.
- B. Manufacturer: Pumps shall be **Ecocirc XL as manufactured by Bell and Gossett** or equivalent meeting all specifications illustrated on the plans and in accordance with the following specifications:
 1. The pumps shall be a wet rotor inline pump, in cast iron or lead free stainless steel body construction specifically designed for quiet operation. Suitable standard operations at 230° F and 175 PSIG working pressure. The pump internals shall be capable of being serviced without disturbing piping connections.
 2. The pump internals shall be capable of being serviced without disturbing piping connections.
 3. Pump shall be equipped with a water-tight seal to prevent leakage.
 4. Pump volute shall be of a cast iron design for heating systems or lead free stainless steel for domestic water systems. The connection style on the cast iron and stainless steel pumps shall be flanged.
 5. Flange to Flange dimension shall be standard Bell & Gossett booster sizes such as 6-3/8", 8-1/2", 11-1/2", and 12". Flange dimensions shall be HVAC industry standard 2 or 4 bolts sizes.
 6. Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
 7. Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
 8. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current, locked rotor and dry run (no load condition).
 9. Pump shall have MODBUS or BACnet connections built into the VFD as standard options.

10. Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
11. Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
12. Pumps shall be UL 778 listed and bear the UL Listing Mark for USA and Canada with on-board thermal overload protection.
13. Each pump shall be factory performance tested before shipment.

C. Operating Modes:

1. Proportional Pressure – The differential pressure will continuously increase or decrease along a linear curve based on the flow demand.
2. Constant Pressure – The pump maintains a constant differential pressure set by the user at any flow demand until the maximum speed is reached.
3. Constant Speed – The pump maintains a constant speed at any flow rate
4. Night Set Back – The pump will recognize a 10°C water temperature reduction and will switch to nighttime operation.
5. T-Constant – This control will use a PI algorithm to vary the speed of the pump in order to maintain a constant temperature of the fluid media.
6. Delta-T Constant – This control mode will use a PI algorithm to vary the speed of the pump in order to maintain a constant differential temperature between the built-in temperature sensor and external temperature sensor.
7. Delta-P-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the fluid temperature.
8. Delta-P-Delta-T – This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the differential temperature between the built-in temperature sensor and external temperature sensor.

3. EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install pump using allowable orientation noted in manufacturer's instruction.
- C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- D. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow and to avoid air pockets.
- E. Provide line sized shut-off valve and pump suction fitting flexible connection on pump suction, and line sized soft seat check valve and balancing valve on pump discharge.
- F. Provide temperature and pressure gauges where and as detailed or directed.
- G. Install valves that are the same size as piping connected to pumps.

- H. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- I. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any load or stress being applied to the connections or piping.

3.3 ELECTRICAL CONNECTIONS

- A. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer's instruction and per applicable state, federal, and local codes.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between temperature controllers and devices.
- C. Power and control wiring shall run in separate conduit.

3.5 START-UP AND COMMISSIONING

- A. Start-up pump in accordance to manufacturer written instructions.
- B. Do not start pump until the system has been filled and vented. Air should be vented from the system by means of an air vent located at a high point in the system. The system must be completely vented prior to pump operation. Do not run circulators dry. Pump operation without water circulation could result in pump and motor damage.
- C. Coordinate pump testing, adjusting and balancing with Balancing Contractor. Complete additional preliminary work required by Balancing Contractor.

END OF SECTION

SECTION 22 30 00 - PLUMBING EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

- A. Domestic water heaters.
- B. Water softeners.
- C. Thermal mixing valves.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Product Certificates: For each type of commercial, gas-fired domestic-water heater.
- C. Retain "Domestic-Water Heater Labeling" Paragraph below if plumbing codes for Project area require domestic-water heaters to be independent-testing-agency certified. Verify availability for units retained.
- D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- E. Sample Warranty

1.4 CLOSEOUT SUBMITTALS

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

1.5 COORDINATION

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

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

- 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.

- 2. Warranty Periods: From date of Substantial Completion.

- a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

- 1) Storage Tank: Five years.
- 2) Controls and Other Components: One year.

- B. Special Warranty: Manufacturer agrees to repair or replace components of water softeners that fail in materials or workmanship within specified warranty period.

- 1. Failures include, but are not limited to, the following:
 - a. Structural failures of mineral and brine tanks.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - d. Attrition loss of resin exceeding 3 percent per year.
 - e. Mineral washed out of system during service run or backwashing period.
 - f. Effluent turbidity greater and color darker than incoming water.
 - g. Fouling of underdrain system, gravel, and resin with turbidity or by dirt, rust, or scale from water softener or soft water, while operating according to manufacturer's written operating instructions.

- 2. Water Softeners, Warranty Period: From date of Substantial Completion.

- a. Mineral Tanks: Five years.
- b. Brine Tanks: 10 years.
- c. Control Valve: One year.

1.7 QUALITY ASSURANCE

- A. See Section 22 05 00.
- B. Perform Work in accordance with State and Local standards.

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Salt for Brine Tanks: Furnish in same form as and at least four times original load. Deliver on pallets. Deliver in pallets according to the following:
 - a. Food-Grade Pellet Salt in 50lb packages
 - b. Plain Pellet Salt in 50lb packages
 - c. Crystallized Solar Salt in 50lb packages
 - d. Plain, Brine Block Salt in 50lb blocks.
 - 2. Store salt on raised platform or pallet where directed by Owner. Do not store in contact with concrete floor.

1.10 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined in accordance with 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. Component Importance Factor: 1.5.
- C. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.
- D. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2. PRODUCTS

- 2.1 Refer to Plumbing Equipment Schedules for performance requirements.

2.2 DOMESTIC NATURAL GAS WATER HEATER

- A. Natural gas water heater(s) shall be A. O. Smith Cyclone Mxi series or equal, minimum 95% thermal efficiency.
- B. Maximum hydrostatic working pressure of 160 psi.
- C. Water heater(s) shall:
 - 1. Modulating gas burner that automatically adjusts the input based on demand.
 - 2. Powered anodes that are non sacrificial and maintenance free.
 - 3. Have seamless glass-lined steel tank construction, with glass lining applied to all water-side surfaces after the tank has been assembled and welded;
 - 4. Meets the thermal efficiency and/or standby loss requirements of the U. S. Department of Energy and current edition of ASHRAE/IES 90.1;
 - 5. Have foam insulation and a CSA Certified and ASME rated T&P relief valve;
 - 6. Have a down-fired power burner designed for precise mixing of air and gas for optimum efficiency, requiring no special calibration on start-up;
 - 7. Be approved for 0" clearance to combustibles.
- D. The control shall be an integrated solid-state temperature and ignition control device with integral diagnostics, graphic user interface, fault history display, and shall have digital temperature readout. No charge connectivity shall be provided allowing for remote viewing and fault notification via app.
 - 1. All models are design certified by Underwriters Laboratories (UL), Inc., according to ANSI Z21.10.3 - CSA 4.3 standards governing storage type water heaters;
 - 2. Meet the thermal efficiency and standby loss requirements of the U. S. Department of Energy and current edition ASHRAE/IES 90.1. Complies with SCAQMD Rule 1146.2 and other air quality management districts with similar requirements for low NOx emissions.
- E. 120K-250K BTU Input: For Power Direct Venting: Water heater(s) shall be suitable for power direct venting using PVC pipe for vent piping and intake air piping.
- F. Operation of the water heater(s) in a closed system where thermal expansion has not been compensated for (with a properly sized thermal expansion tank) will void the warranty.
- G. Alternative Manufacturers: Subject to compliance with requirements, provide one of the following:
 - 1. Lochinvar Corporation.
 - 2. PVI Industries, LLC.
 - 3. Or equivalent.

2.3 WATER SOFTENERS

- A. Performance: See schedule on drawings.
- B. Softener Tank: Glass fiber reinforced plastic tank, 125 psig construction, NSF 44 listed materials.
- C. Brine Tank: HDPE construction.

- D. Control: Control valve assembly shall be top-mount design with support package assembled to resin tank. Valve body shall be constructed from solid brass, capable of performing all system regeneration functions without the use of diaphragm valves. The piston control will open and close slowly to prevent hydraulic shock and noise. Controls shall be mounted in a gasketed, moisture-resistant enclosure with a NEMA 3R standard rating.
- E. Regeneration: A solid bronze meter shall be supplied on the outlet of the softener. The meter shall have an electronic interface with the main controls and will initiate regeneration on a volume basis or day override. Flow rate, totalizer, system status, time of day will be viewable from the meter control.

2.4 THERMAL MIXING VALVES

- A. Manufacturer: Subject to compliance with scheduled requirements, provide product by one of the following:
 - 1. Leonard Valve Company (Basis of Design)
 - 2. Powers
 - 3. Armstrong International, Inc.
 - 4. Or equivalent.
- B. Mixing Valve shall be Digital and comply with National Low Lead Laws @< .25% Lead
- C. Digital mixing valve shall:
 - 1. have 1" inlet/ 1 1/4" outlet connections with integral stop/check valves
 - 2. 2-line, 16-character LED display
 - 3. Integral RTD Sensor
 - 4. Deliver mixed water flow of 95 GPM @ 30 PSI Pressure Drop
 - 5. Maintain temperature with .25 GPM flow from the domestic hot water loop
- D. PNV-125-LF shall have all the following operational capabilities:
 - 1. 1X per day shuttle sweep designed to prevent scale buildup on internal mechanical components
 - 2. +/- 2°F water temperature control at times of use and no demand
 - 3. 2°F minimum inlet to outlet water temperature differential
 - 4. Automatic shutoff of hot water upon cold water inlet supply failure
 - 5. Automatic shutoff of cold water upon hot water inlet supply failure
 - 6. Maintain last control position in the event of power failure or be equipped with UPS standby power for approximately 2 hour run time
 - 7. Programmable set point range of 65-180°F (18-82°C)
- E. Digital mixing valve shall be certified to ASSE standard 1017 and CSA B125.3-18 and so certified and identified
- F. Digital mixing valve shall be cULus listed and identified
- G. Maximum Operating Pressure shall be no greater than 125 PSI

- H. Wi-Fi Connectivity shall be available with Proton 3.0 box in addition to BACnet MS/TP connection, Disinfection, relay, and 3 additional temperature probes for hot and cold inlet in addition to return

3. EXECUTION

3.1 DOMESTIC NATURAL GAS WATER HEATER INSTALLATION

- A. Install water heater in accordance with manufacturer's instructions.
- B. Install unit with clearance for tube bundle removal without disturbing other installed equipment or piping.
- C. Install unit with manufacturer recommended clearances for service.
- D. Pipe relief valves and drains to nearest floor drain.
- E. Connect steam branch line from top of main. Pipe in flexible manner, pitched with steam flow, with pipe union connections. Provide steam pressure gauge at water heater inlet.
- F. Provide steam traps and valves as indicated.
- G. Where installing piping adjacent to domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.2 WATER SOFTENER INSTALLATION

- A. Install softeners and brine tanks in accordance with manufacturer's instructions.
- B. Pipe relief valves and drains to nearest floor drain.
- A. Equipment Mounting: Install water softeners on concrete base sized for unit.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Anchor water softener and brine tanks to substrate.
- B. Install brine lines and fittings furnished by equipment manufacturer but not specified to be factory installed.
- C. Prepare mineral-tank distribution system and underbed for minerals and place specified mineral into mineral tanks.

3.3 THERMAL MIXING VALVE INSTALLATION

- A. Install thermal mixing valve in accordance with manufacturer's instructions.

- D. Equipment Mounting: Install thermal mixing valve on 2" uni-strut.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Install thermal mixing valve and fittings furnished by equipment manufacturer but not specified to be factory installed.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Water softeners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Provide start up reports
- B. Water Softeners
 - 1. Add water to brine tanks and fill with salt per manufacturer recommendations.
 - a. Sample water softener effluent after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics. Comply with the following:
 - 1) ASTM D 859, "Test Method for Silica in Water."
 - 2) ASTM D 1067, "Test Methods for Acidity or Alkalinity of Water."
 - 3) ASTM D 1068, "Test Methods for Iron in Water."
 - 4) ASTM D 1126, "Test Method for Hardness in Water."

- 5) ASTM D 1129, "Terminology Relating to Water."
- 6) ASTM D 3370, "Practices for Sampling Water from Closed Conduits."

C. Thermal mixing valves

1. Follow manufacturer's recommendations for start-up and adjust outlet temperatures from valves to scheduled value.
2. For thermal mixing valves serving emergency fixtures, verify that valve still operates in the event of a hot water supply failure
 - a. If valve fails to supply water in event of hot water failure then valve shall be considered defective and shall be replaced/repaired.
3. Adjust circulation lines to scheduled flow and verify presence of scheduled tempered water at all fixtures.

D. Domestic water heater(s).

1. Follow manufacturer's recommendations for start-up and adjust outlet temperatures from water heater(s) to scheduled value.
2. Fill domestic water heater with water.
3. Charge domestic water expansion tanks with air.
4. Adjust circulation lines to scheduled flow and verify presence of 'hot' water at all fixtures.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain plumbing equipment.

END OF SECTION

SECTION 22 40 00 - PLUMBING FIXTURES

1. GENERAL

1.1 SECTION INCLUDES

- A. Plumbing fixtures.
- B. Installation requirements of plumbing fixtures scheduled in Plumbing Fixture Schedule.
- C. Plumbing fixture carriers.

1.2 DEFINITIONS

- A. Retain terms that remain after this Section has been edited for a project. Include only essential definitions or acronyms not well understood by the affected industry or trade.
- B. FRP: Fiberglass-reinforced plastic.
- C. PMMA: Polymethyl methacrylate; also known as "acrylic."
- D. Standard-Efficiency Flush Volume: 1.6 gal per flush.
- E. High-Efficiency Flush Volume: 1.28 gal or less per flush.
- F. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for plumbing fixtures.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Plans, elevations, sections, and mounting and/or attachment details.
 - 2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data:

1. For lavatories and faucets.
 - a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1) Servicing and adjustments of automatic faucets.
2. For shower valves to include in maintenance manuals
3. For sinks and faucets to include in operation and maintenance manuals.
 - a. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - 1) Servicing and adjustments of automatic faucets.
4. For flushometer valves and electronic sensors to include in operation and maintenance manuals.
5. For wash fountains and components to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 3. Shower Valve Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 4. Shower Valve Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
 5. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

1.6 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING GUIDELINES

- A. References
- B. Additional submittal requirements.
- C. Quality Assurance
- D. Delivery, Storage and Handling
- E. Closeout Submittals

1.7 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings and instructed by the manufacturer.
- B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

1.8 PERFORMANCE REQUIREMENTS

- A. Lavatory faucets, sink faucets, shower valves, and wash fountain spray heads and faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.
- C. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.
- D. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.
- E. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
- F. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.
- G. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.
- H. 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.

2. PRODUCTS

2.1 PLUMBING FIXTURES

- A. Refer to Plumbing Fixture Schedule for all required product information.
- B. The Contractor is responsible for ensuring that all roof drains are compatible with roof types and roof insulation. Refer to architectural and structural plans for roof information. No additional compensation will be allowed for failure to coordinate roof drains with roof types.
- C. Mobile Whirlpools:
 - 1. Provide Whitehall Mobile Whirlpool WHS-110-M equivalent with a 110-gallon capacity,

2. 56"L x 24"W x 25"D. Whirlpool shall be fabricated from heavy gauge, type 304 stainless steel. Construction shall be seamless welded and exposed surfaces shall be polished to satin finish. Bottom of tank shall be a seamless, rounded coved design. Whirlpool shall have heavy duty swivel casters with locking device on rear pair of casters. Provide a turbine assembly with raising and lowering device which functions both as agitator and emptying device, permits adjustment of desired height, direction of water agitation, and can be locked into place. Turbine assembly shall be UL listed 1/2 HP jet pump motor with automatic thermal overload protector and lifetime-sealed bearings. Provide a thermometer with a stem retainer to prevent rattling when whirlpool is in operation.
 - a. Turbine electrical requirements: 115VAC/60 Hz (6.2 AMPS)
 - b. Provide with separate drain option: Bottom drain, leading to a separate, concealed water evacuation pump. A hose shall be attached to the side of the unit to facilitate the evacuation.
 - c. the evacuation.
 - d. Mixing Valve: Whitehall MXT15-OTG or equal:
 - 1) Mixing Valve Assembly shall be factory assembled and tested. The Thermostatic Mixing Valve shall comply with ASSE and CSA standards. Valve shall contain a copper encapsulated, paraffin-based Thermal Actuator. Valve shall be a chrome plated, solid DZR brass body with a capacity of 15 GPM (57 LPM) at 45 PSI (310 kPa) differential and a maximum operating pressure of 125 PSIG (862 kPa). Supply pressure variation shall be up to 20%. Valve shall have a maximum outlet temperature of 110°F (43°C). Assembly shall include an Outlet Temperature Gauge, Lockable Inlet and Outlet Ball Valves, and a Vacuum Breaker. Valve shall comply with ASSE 1069, ASSE 1070 and CSA B125.3 standards.
 - a) Provide w/ outlet temperature gauge that provides a visual indication of outlet water temperature.
 - b) Provide with filler hose assembly: 3/4" x 48" Braided Stainless Steel Hose with 3/4" Adapters.
 - e. Refer to Plumbing Fixture Schedule for additional requirements.

2.2 PLUMBING FIXTURE CARRIERS

- A. All wall mounted fixtures such as urinals, water closets, lavatories, drinking fountains, electric water coolers, etc. shall be installed with compatible carriers. All carriers shall be commercial or industrial grade and shall be suitable for the fixture served, space available and building construction. All carriers shall extend to the floor and be anchored into the slab.
- B. Water closet carriers shall be heavy-duty type, rated for a minimum of 500 lbs.

3. EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.
- B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.
- D. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

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

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install each fixture with trap with 2 slip joints, easily removable for servicing and cleaning.
- C. Provide chrome plated rigid or flexible supplies to fixtures with stops, reducers, and escutcheons.
- D. Install components level and plumb.
- E. Install and secure fixtures in place with scheduled wall supports or wall carriers and bolts.
- F. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.

3.4 INSTALLATION OF PIPING CONNECTIONS

- A. Connect plumbing fixtures with water supplies and soil, waste, and vent piping. Use size fittings required to match plumbing fixtures.
- B. Comply with water piping requirements specified in Section 22 10 00 "Plumbing Piping."
- C. Comply with soil, waste, and vent piping requirements specified in Section 22 10 00 "Plumbing Piping."
- D. Install protective-shielding pipe covers and enclosures on exposed supplies and waste piping of accessible plumbing fixtures. Comply with requirements in Section 22 07 19 "Plumbing Piping Insulation."
- E. Where installing piping adjacent to water closets and urinals, allow space for service and maintenance.

3.5 INSTALLATION OF ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Division 26 requirements.
- B. Ground equipment in accordance with Division 26 requirements.
- C. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

3.6 INSTALLATION OF CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26 requirements.

3.7 WATER CLOSET INSTALLATION

A. Water-Closet Installation:

- 1. Install level and plumb according to roughing-in drawings.
- 2. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.
- 3. Where installing piping adjacent to water closets, allow space for service and maintenance.

B. Support Installation:

- 1. Use carrier supports with waste-fitting assembly and seal.
- 2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
- 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
- 4. Install actuators in locations that are easy for people with disabilities to reach.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

- 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
- 2. Install deep-pattern escutcheons if required to conceal protruding fittings.

F. Joint Sealing:

- 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
- 2. Match sealant color to water-closet color.

3.8 URINAL INSTALLATION

A. Urinal Installation:

- 1. Install urinals level and plumb according to roughing-in drawings.
- 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.

3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.

B. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.

3.9 LAVATORY AND SINK INSTALLATION

A. Lavatory and Sink Installation:

1. Install lavatories and sinks level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories and sinks.
3. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1. Coordinate exact locations with drawings.
4. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
5. Install trap and waste piping on each drain outlet of each lavatory to be connected to sanitary drainage system.
6. Seal joints between lavatories/sinks, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.
7. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sinks.
8. Install water-supply piping with stop on each supply to each faucet.
 - a. Exception: Use ball, gate, or globe valves if supply stops are not specified with lavatory/sink.
 - b. Install stops in locations where they can be easily reached for operation.

3.10 SHOWER INSTALLATION:

1. Assemble shower components in accordance with manufacturers' written instructions.
2. Install showers level and plumb in accordance with roughing-in drawings.
3. Install ball valves in water-supply piping to the shower if supply stops are specified with the shower valve. Install valves in locations that are accessible for ease of operation.
4. Install shower flow-control fittings with specified maximum flow rates in shower arms.
5. Set shower basins in leveling bed of cement grout.
6. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
7. Seal joints between showers, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

3.11 WATER COOLER INSTALLATION:

- A. Install fixtures level and plumb in accordance with roughing-in drawings. For fixtures indicated for juveniles, install at height required by authorities having jurisdiction.
- B. Set pedestal drinking fountains and bottle filling stations on flat surface in accordance with manufacturer's written installation instructions.
- C. Set freestanding water coolers on floor.
- D. Install recessed drinking fountains and bottle filling stations secured to wood blocking in wall construction.
- E. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- F. Install mounting frames, affixed to building construction, and attach recessed water coolers and bottle filling stations to mounting frames.
- G. Set remote water coolers on floor unless otherwise indicated.
- H. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation.
- I. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- J. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.
- K. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.12 INTERFACE WITH OTHER PRODUCTS

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

3.13 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.
- B. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning plumbing fixtures, fittings, and controls.
- C. Adjust water pressure at faucets, shower valves, and flushometer valves to produce proper flow.
- D. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.14 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 5. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

3.15 CLEANING AND PROTECTION

- A. Directly prior to project turnover, clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Inspect and repair damaged finishes. Replace any fixtures unable to be repaired to the satisfaction of the Architect or Owner.
- C. Install protective covering for installed water closets, urinals, and fittings.
- D. Do not allow use of plumbing fixtures for use during construction unless approved in writing by Owner.

END OF SECTION

22 61 13 – COMPRESSED AIR SYSTEMS

1. GENERAL

1.1 SECTION INCLUDES

A. Equipment and accessories for:

1. Compressed air system.

1.2 ACTION SUBMITTALS

A. Product Data: For each product.

1. For each type of product.
 - a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - b. Include operating characteristics, electrical characteristics, and furnished accessories.

B. Shop Drawings:

1. Plans, elevations, sections, and mounting / attachment details.
2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations and size of each field connection.
3. Diagrams for power, signal, and control wiring.

C. Delegated Design Submittals: For compressed-air equipment mounting.

1. Detail fabrication and assembly of supports.
2. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.3 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For compressed-air equipment, 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.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressed-air equipment.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Air Compressor, Inlet-Air-Filter Elements: Equal to 10% percent of amount installed, but no fewer than 1 units.
 - 2. Belts: One for each belt-driven compressor.

1.6 COORDINATION

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written instructions for delivery, storage, and handling.

1.8 WARRANTY

- A. Manufacturer Warranty: Manufacturer agrees to repair or replace equipment that fail in materials or workmanship within the specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

1.9 REFERENCE SECTION 22 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References.

1.10 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label receivers to comply with ASME Boiler and Pressure Vessel Code.
- C. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design compressed-air equipment mounting.
- D. Seismic Performance: Compressed-air equipment to withstand the effects of earthquake motions determined in accordance with 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. Component Importance Factor: 1.0.

2. PRODUCTS

2.1 AIR COMPRESSOR:

- A. See compressed air equipment schedule on drawings.

2.2 AIR DRYER:

- A. See compressed air equipment schedule on drawings.

2.3 PIPE AND FITTINGS

- A. Refer to specification section 22 10 00 "Plumbing Piping".

2.4 VALVES

- A. Refer to specification section 22 10 00 "Plumbing Piping".

2.5 AIR FILTERS

- A. See compressed air equipment schedule on drawings.

2.6 PIPING ACCESSORIES

- A. Hangers and Supports: MSS SP-58 with types as required by MSS SP-69.
- B. Pressure Gauges:
 - 1. ANSI B40.1, white dials, and black lettering with restrictor.
 - 2. Manufactured and labeled expressly for intended service; UL labeled.
- C. Flexible Connectors: Corrugated flexible, single ply, seamless or seam-welded tubing of stainless steel or bronze or reinforced teflon bellows or hose.

2.7 FLOW CONTROLLERS

- A. See compressed air equipment schedule on drawings.

3. EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of compressed air piping to verify actual location before air compressor installation.

3.2 INSTALLATION OF EQUIPMENT

- A. Equipment Mounting:
 - 1. Install air compressors and air dryers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
- B. Install compressed-air equipment anchored to substrate.

- C. Arrange equipment so controls and devices are accessible for servicing.
- D. Maintain manufacturer's recommended clearances for service and maintenance.
- E. Install the following devices on compressed-air equipment:
 - 1. Thermometer, Pressure Gauge, and Safety Valve: Install on each compressed-air receiver.
 - 2. Pressure Regulators: Install downstream from air compressors and dryer.
 - 3. Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 22 10 00 "Plumbing Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Division 26.
- B. Ground equipment in accordance with Division 26.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 IDENTIFICATION

- A. Identify general-service air compressors and components. Comply with requirements for identification specified in Section 220553 "Plumbing Identification."

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Check for lubricating oil in lubricated-type equipment.
 - 3. Check belt drives for proper tension.
 - 4. Verify that air compressor inlet filters and piping are clear.
 - 5. Check for equipment vibration-control supports and flexible pipe connectors, and verify that equipment is properly attached to substrate.

6. Check safety valves for correct settings. Ensure that settings are higher than air compressor discharge pressure, but not higher than rating of system components.
7. Check for proper seismic restraints.
8. Drain receiver tanks.
9. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
10. Test and adjust controls and safeties.

3.8 ADJUSTING

- A. Adjust equipment to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air compressor and air dryer.

END OF SECTION

SECTION 23 05 00 - BASIC HVAC REQUIREMENTS

1. GENERAL

1.1 SECTION INCLUDES

- A. This section describes Basic Mechanical Requirements to provide for a complete installation of all mechanical systems for this project. This section shall apply to all other Division 23 specification sections as well as all work shown on the drawings.
- B. It is the intent of the Mechanical Division of the Specifications that all mechanical work specified herein be coordinated as required with the work of all other Divisions of the Specifications and Drawings so that all installations operate as designed.
- C. All systems shall be completely assembled, tested, adjusted and demonstrated to be ready for operation to the satisfaction of the Owner's representative.
- D. The Contractor shall note that, in some cases, piping as shown on the Drawings provide general location and routing information only. The Contractor shall be responsible for providing interference-free systems with proper clearance to facilities and equipment.
- E. Where the word "provide" is used, it shall mean "furnish and install" unless otherwise noted or specified.
- F. Note that the words "mechanical" and "plumbing" are used interchangeably throughout the Division 22 and 23 specification sections.

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this section and all other sections of Division 23.

1.3 DESCRIPTION OF WORK

- A. The work included under this section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete mechanical systems required by these specifications and/or shown on the drawings of the contract.
- B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, piping, ductwork, etc.

1.4 QUESTIONS OF INTERPRETATION

- A. If questions arise during the bidding process regarding the meaning of any portion of the contract documents, the prospective bidder shall submit the questions to the Architect/Engineer for clarification. Any definitive interpretation or clarification of the contract documents will be published by addenda, properly issued to each person holding documents, prior to the bid date. Verbal interpretation or explanation not issued in the form of an addendum shall not be considered part of the bidding documents. When submitting questions for clarification, adequate time for issuance and delivery of addenda must be allowed.
- B. The Architect/Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

1.5 CONTRACT DOCUMENT DISCREPANCIES

- A. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Architect/Engineer before proceeding with the work. If the Contractor fails to make such request, no excuse will thereafter be entertained for failure to carry out the work in a manner satisfactory to the Architect/Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work unless a written clarification from the Architect/Engineer was requested and obtained before submission of bid.
- B. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of three-dimensional objects. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies should be identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
- C. The Contractor shall follow the drawings in laying out work and verify clearances for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of materials or equipment, obtain instructions from the Architect/Engineer before proceeding with the work.
- D. If there is a conflict between manufacturer's recommendations and the Contract Documents, the manufacturer's recommendations shall govern with no additional cost to the Owner.

1.6 PERMITS

- A. The Contractors shall familiarize themselves with all requirements regarding all permits, fees, etc., and shall comply with them. All permits, licenses, inspections and arrangements required for the work shall be obtained by the Contractor at his expense.
- B. All utilities shall be installed in accordance with the local rules and regulations and all charges shall be paid by the Contractor.

1.7 QUALITY ASSURANCE

- A. Installers shall have at least 2 years of successful installation experience on projects with mechanical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation, unless noted otherwise in other mechanical sections.
- B. Manufacturer of equipment and materials must be regularly engaged in the manufacture of the specified equipment and material with similar construction and capacities and whose products have been in satisfactory use in similar service for not less than five (5) years, unless noted otherwise in other Mechanical Sections.
- C. Qualify welding processes and operators for structural steel according to AWS D1.1. "Structural Welding Code - Steel.
- D. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."
- E. Comply with provisions of ASME B31 Series "Code for Pressure Piping", including all addenda.
- F. Contractor signed welder certificate(s) shall be submitted. Certify that each welder has passed AWS qualification tests for the welding processes involved and that certification is current. A record shall be maintained on the job site showing the date and results of qualification tests for each welder employed on the job. One certified copy of the qualification test for each welder so employed shall be furnished to the Owner's representative.
- G. For all the refrigerant work/service required by this project, all refrigerant technicians shall be EPA/ASHRAE 34 certified for corresponding classification type I, II, III and/or IV.

1.8 REFERENCES

- A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following as applicable:
 - 1. Safety and Health Regulations for Construction.
 - 2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
 - 3. ABMA - American Boiler Manufacturers Association.
 - 4. ACCA - Air Conditioning Contractors of America.
 - 5. ACGIH - American Conference of Governmental Industrial Hygienists.
 - 6. ADC - Air Diffusion Council.
 - 7. AGA - American Gas Association.
 - 8. AIHA - American Industrial Hygiene Association.
 - 9. AMCA - Air Movement and Control Association.
 - 10. ANSI - American National Standards Institute.
 - 11. ARI - Air-Conditioning and Refrigeration Institute.
 - 12. ASA - Acoustical Society of American.
 - 13. ASHRAE - American Society of Heating, Refrigerating, and Air-Conditioning Engineers.
 - 14. ASME - The American Society of Mechanical Engineers.
 - 15. ASTM - American Society of Testing and Materials.
 - 16. CAGI - Compressed Air and Gas Institute.
 - 17. CTI - Cooling Tower Institute.
 - 18. EJMA - Expansion Joint Manufacturers Association.
 - 19. ETL - Engineering Tests Laboratory.
 - 20. HEI - Heat Exchange Institute.

21. HI - Hydraulic Institute.
22. HYD I - Hydronics Institute.
23. ICBO - International Conference of Building Officials.
24. ICC – International Code Council.
25. NEBB - National Environmental Balancing Bureau.
26. NEC - National Electrical Code.
27. NEMA - National Electrical Manufacturers Association.
28. NFPA - National Fire Protection Association.
29. NSF - National Sanitation Foundation.
30. SAE - Society of Automatic Engineers.
31. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association.
32. TEMA - Tubular Exchanger Manufacturers Association.
33. UL - Underwriters Laboratories, Inc.
34. International Plumbing Code.
35. International Mechanical Code.
36. Other governing, state, and local codes that apply.

1.9 SUBMITTALS

- A. General: Follow the procedures specified in Division 1 Sections "General Conditions" and "Special Conditions".
- B. The Architect/Engineer's review of submittals including any corrections or comments made on the shop drawings during the review process, do not relieve Contractor from compliance with requirements of the Contract Documents. The review is only a review of general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. The Contractor is responsible for confirming and correlating all quantities and dimensions, selecting fabrication process and techniques of construction, coordinating his work with that of all other trades, and performing his work in a safe and satisfactory manner. The Contractor shall not be relieved from responsibility for errors or omissions in the shop drawings, product data or samples by the Architect/Engineer's review of those drawings.
- C. No portion of the work requiring submission of a shop drawing, product data or sample shall be commenced until the submittal has been reviewed by the Architect/Engineer. All such portions of the work shall be in accordance with reviewed submittals and the associated manufacturer recommendations.
- D. Shop drawings shall include the minimum following information as applies. Additional specific information required is outlined in other Mechanical Sections.
 1. All equipment items shall be marked with the same item number as used on drawings or schedules.
 2. Certified performance and data with system operating conditions indicated. All coil, fan, energy recovery, terminal unit, sound attenuation, and pump performance data shall be computer generated.
 3. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicating size, weights (shipping, installed, and operating), furnished specialties and accessories; and installation and start-up instructions.
 4. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loading, required clearances, and methods of assembly of components.

5. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to electrical equipment. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of electrical equipment and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
6. Maintenance Data: Submit maintenance data and parts list for each mechanical equipment, control and accessory; including "troubleshooting" maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

E. Coordination drawings

1. Drawings:
 - a. Provide coordination in determining adequate clearance and space requirements for fire suppression equipment, mechanical equipment, electrical equipment, and other items/equipment in the project. The Architect/Engineer reserves the right to determine space priority of equipment in the event of interference between pieces of equipment, piping, conduit, ducts and equipment of the trades. The Architect/Engineer will only review conflicts and give an opinion but will not perform as a coordinator.
 - b. Provide coordination drawings indicating structural components, reflected ceiling layout, fire suppression items, mechanical items, electrical items, and other systems. Indicate on the coordination drawings where components will be installed and how the service access area to such items shall be maintained. Illustrate items requiring access for maintenance or adjustment.
 - c. The Contractor will not be allowed any time extensions for participation in the coordination drawing process. The Contractor will not be allowed any contract cost extra for any additional fittings, rerouting or changes of duct size to equivalent sizes to those shown on the drawings that may be determined necessary through the coordination drawing process.
 - d. Deviations from the contract documents that are necessary for overall system installation and coordination shall be brought to the attention of the Architect/Engineer. Such necessary changes in the contract scope discovered through the coordination drawing process will be covered by the requirements of the "change order" process.
 - e. Access panels shall occur only in gypsum wallboard or plaster ceilings where indicated on the drawings or as needed to provide access to equipment, dampers, or valves. Access to fire suppression and other items shall be through accessible acoustical ceiling areas. Additional access panels will not be allowed without written approval from the Architect/Engineer at the coordination drawing stage and only after alternatives are reviewed. Layout changes shall be made to avoid additional access panels. If additional access panels are required, they shall be provided at no additional cost to the Owner.
 - f. Soffit penetrations and light alcoves shall be fully coordinated with hanging devices, studs, fire/smoke ratings, and structural support requirements.
2. The Contractor and subcontractors responsible for items of work located in or above ceilings shall participate in the coordination drawing process. Participation is mandatory. If the Contractor or subcontractor fails to participate in the coordination drawing process, the Owner reserves the right to do the following:

- a. Stop construction progress payments for work performed by the Contractor. Payments will be reinstated only after the Contractor or subcontractor resumes participation in the coordination drawing process.
 - b. Require the relocation and resizing of components as necessary to ensure components will be installed as intended. In the event the Contractor did not participate in the coordination process, the Contractor will not be entitled to contract cost increases or time extensions due to Owner-initiated changes in the work.
 - c. The Contractor shall be held responsible for unnecessary rework that is attributable to failure to participate in the coordination process.
3. Drawings shall be prepared at 1/4 inch = 1 foot, 0 inches (minimum).
 - a. Coordination participants shall provide equipment installation and clearance requirements. This information shall be indicated on the coordination drawings.
 - b. Coordination drawings shall indicate the following major system components (including insulation, hub or connection widths with verification of turning radius):
 - 1) Roof drain leaders
 - 2) Large waste piping
 - 3) Sprinkler mains
 - 4) Equipment located above the ceiling
 - 5) Heating hot water piping
 - 6) Chilled water piping
 - 7) Conduit runs 2 inches and larger
 - 8) Cable tray
 - 9) Bus duct
 - 10) Recessed light fixtures
 - 11) Building wiring or cable trays
 - 12) Ceiling heights as shown in contract documents and thickness of system
 - 13) Soffits (including framing of supports)
 - 14) Access points and clearances required
 - 15) Access panels
 - 16) Valves
 - 17) Dampers
 - 18) Coils
 - 19) Ductwork
 - 20) Fire-rated wall, partition, and floor penetrations
 - 21) Steam and condensate piping
 - 22) Space allotted for future utilities
 - 23) Equipment in mechanical and electrical spaces
 - c. Information shall be delineated to indicate distances from column centerlines, pipe/equipment size, and distance from finished floor to bottom of pipe/equipment and hangers.
4. The coordination drawings shall be submitted to the Architect/Engineer and Owner's representative for review. The submitted coordination drawings shall indicate which contractors participated in the process and where conflicts appear to occur even after the priority ranking of utility routing has been utilized. In the event that conflicts require input from the Architect/Engineer, recommended solutions will be provided with the coordination drawings for review by the Architect/Engineer. The Architect/Engineer will review and return an opinion to the contractors for implementation. All contractors shall agree to the final coordinated layout by signing off on the coordination drawings before any construction can begin.

5. Maintain an updated set of coordination drawings at the job site reflecting changes, modifications and adjustments. Changes shall be reflected and sets or new sheets reissued to the Architect/Engineer and the Owner for review on a monthly basis with changes "clouded" and brought to the attention of the Architect/Engineer and the Owner.
6. When a change order request is issued, the affected subcontractors shall review the coordination drawings and bring to the attention of the Contractor and the Architect/Engineer revisions necessary to the work of others not directly affected by the change order.
7. Contractors that fail to cooperate in the coordination drawing effort shall be responsible for all costs incurred for adjustments to the work made necessary to accommodate installations. Provide adequate clearance and access through accessible ceilings. Conflicts that result after the coordination drawings are signed off will be the responsibility of the Contractor or subcontractor who did not properly identify their work or installed the work improperly.

F. Provide separate shop drawing submittals for the following items:

1. Section 23 05 00:

Submittal Requirement:	Date Submitted:
HVAC permits	
HVAC licenses	
EPA/ASHRAE 34 refrigeration certification for type I, II, III&/ or IV services	
Welding certificates	
Warranties	
Coordination drawings	
As-built documents	
Piping pressure test logs	
Operation and maintenance manuals	
Close-out / walk-through documentation	
Owner training documentation	

2. Section 23 05 19:

Submittal Requirement:	Date Submitted:
HVAC meters and gauges	

3. Section 23 05 29:

Submittal Requirement:	Date Submitted:
HVAC hangers and supports	

4. Section 23 05 48:

Submittal Requirement:	Date Submitted:
HVAC seismic and vibration isolation controls	

5. Section 23 05 53:

Submittal Requirement:	Date Submitted:
HVAC identification materials	

6. Section 23 05 93:

Submittal Requirement:	Date Submitted:
Pre-balancing conference meeting notes	
Pre-balancing field deficiency report	
Draft TAB report	
Final TAB report	

7. Sections 23 07 13, 23 07 16, & 23 07 19

Submittal Requirement:	Date Submitted:
Ductwork insulation materials and insulation schedule	
HVAC Piping insulation materials and insulation schedule	

8. Sections 23 09 00, 23 09 01 & 23 09 93:

Submittal Requirement:	Date Submitted:
Control drawings	
Control materials and equipment	
Sequence of operation	
Points list	
Documentation of owner training	
Electronic backup copy of the BAS controls	
Programs, and printed copy of all set points after the one year warranty	

9. Section 23 21 13:

Submittal Requirement:	Date Submitted:
HVAC pipe schedule and material	
HVAC pipe fittings	

10. Section 23 31 13:

Submittal Requirement:	Date Submitted:
Ductwork material and schedule	
Flexible ductwork	
Low pressure manufactured ductwork fittings	
Ductwork hangers, sealants, tapes, etc.	
Ductwork connection systems	

11. Section 23 33 00:

Submittal Requirement:	Date Submitted:
Dampers	
Flexible duct connections	
Duct access doors	
Duct test hole plugs	
Volume control dampers	
Damper quadrants	

12. Section 23 34 23:

Submittal Requirement:	Date Submitted:
Power ventilators	

13. Section 23 36 00:

Submittal Requirement:	Date Submitted:
Air terminal units	

14. Section 23 37 00:

Submittal Requirement:	Date Submitted:
Air outlets and inlets	

15. Section 23 51 00:

Submittal Requirement:	Date Submitted:
Combustion air piping for water heaters	
Vent piping for water heaters	

16. Section 23 74 00:

Submittal Requirement:	Date Submitted:
All scheduled packaged outdoor HVAC equipment	

17. Section 23 74 01:

Submittal Requirement:	Date Submitted:
All rooftop mechanical equipment screens	

18. Section 23 82 39:

Submittal Requirement:	Date Submitted:
All scheduled heat transfer units	

1.10 SUBSTITUTIONS

- A. All proposals shall be based on providing and installing the materials or items of equipment as shown on the Contract Documents. The Contractor's options in selecting materials and equipment are limited by requirements of the Contract Documents and governing regulations. They are not controlled by industry traditions or procedures experienced by the Contractor on previous construction projects.
- B. Where the terms "or equivalent" is used, the Contractor may substitute alternate equipment, materials, etc. subject to review by the Architect/Engineer and the Owner's representative during the submittal phase of the project.
- C. Where the term "or approved equivalent" is used, the Contractor may not substitute alternate equipment, materials, etc. unless requesting approval at least ten (10) days before the bid date. Notifications of any such approvals by the Architect/Engineer shall only be made in writing by Addendum.
- D. Where the term "no equivalent" is used, the Contractor must provide the specified or scheduled equipment, materials, etc.
- E. Proposed substitutions will be judged on the basis of quality, capacity, performance, features, physical size, and appearance. The reputation of the manufacturer, delivery time requirements, and the availability of repair or replacement parts may also be considered.
- F. The Architect/Engineer shall be the sole and final judge as to the suitability of substitution items.
- G. If a substitution is approved, the Contractor shall bear the total cost of all changes due to substitution. These costs may include additional compensation to the Architect/Engineer for redesign and evaluation services, increased cost of work by the Owner or other Contractors, and similar considerations.

1. If an approved substitution differs from the specified item in terms of power requirements, dimensions, capacities, and ratings, the associated mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are to be increased accordingly, but all recommended manufacturer clearances, etc., are to be maintained within the allotted mechanical spaces. No additional costs will be approved for these modifications. If minimum energy ratings or efficiencies of the equipment are specified, the equipment must meet the design requirements and commissioning requirements.

1.11 WARRANTY

- A. Refer to the General Conditions section of this Specification for general warranty requirements and information. Additional warranty requirements are specified in subsequent Mechanical Sections.

1.12 CLOSE OUT AND OPERATION INSTRUCTIONS

- A. Operate each system and item of equipment in a test run of appropriate duration, but no less than 7 days, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.
- B. Systems shall not be used for temporary operation during construction without written approval from the Architect/Engineer. If approved and used during construction, all systems must be properly maintained and operated according to manufacturer recommendations. Immediately prior to turnover to the Owner, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations, including, but not limited to, filter replacement, strainer cleaning, belt adjustment, etc.
- C. Any system placed in temporary operation for testing or for the convenience of the Contractor during construction shall be properly maintained and operated by the Contractor.
- D. All systems shall be protected against freezing, flooding, corrosion or other forms of damage prior to acceptance by the Owner.
- E. Material or equipment damaged, shown to be defective or not in accordance with the Specifications shall be repaired or replaced to the satisfaction of the Owner's representative.
- F. All tests shall be made after notification to and in the presence of the Owner's representative.
- G. Before starting up any system, each piece of equipment comprising any part of the system shall be checked for proper lubrication and any other condition which may cause damage to the equipment or endanger personnel.
- H. After systems have been demonstrated to be satisfactory for 7 consecutive days and ready for permanent operation, all permanent pipe line strainers shall be cleaned, valve and packings properly adjusted, lubrication checked and replenished if required. Temporary piping, etc. shall be removed and openings restored in a permanent manner acceptable to the Owner's representative.

- I. Conduct a walk-through instruction seminar for the Owner's personnel pertaining to the continued operation and maintenance of mechanical equipment and systems. Explain the identification system, maintenance requirements, operational diagrams, temperature control provisions, sequencing requirements, security, safety, efficiency and similar features of the systems. Walk through must be documented as to those attending and subjects covered. Walk through document(s) shall be signed and dated by the contractor's representative and the owner's representative.
- J. At the time of substantial project completion, turn over the prime responsibility for operation of the mechanical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.
 - 1. If any systems are operated prior to substantial completion, the contractor shall perform all necessary preventative maintenance according to all manufacturer recommendations.

1.13 AS-BUILT DOCUMENTS

- A. Prepare as-built documents in accordance with the requirements in Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in above, indicate the following installed conditions:
 - 1. The Mechanical Contractor shall provide the Owner with as-built drawings for ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units and indicate all devices requiring periodic maintenance or repair.
 - 2. All mechanical systems as described in the Specifications and/or shown on the drawings.
 - 3. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section "Mechanical Identification." Indicate actual inverts and horizontal locations of underground piping.
 - 4. Equipment/material locations (exposed and concealed), dimensioned from prominent building lines.

1.14 MAINTENANCE MANUALS

- A. Per International Energy Code, paragraphs 803.3.8 and 803.3.8.3, Prior to the issuance of a certificate of occupancy, the mechanical contractor shall submit a minimum of one week before the request for building certificate of occupancy operating and maintenance manuals. The manuals shall include at a minimum the following.
 - 1. Equipment capacity (input and output) and required maintenance actions.
 - 2. Equipment operation and maintenance manuals.
 - 3. HVAC system control maintenance and maintenance and calibration information, including wiring diagrams, schematics, control sequence descriptions. Desired or field determined set points shall be permanently recorded on control drawings, at control devices or, for digital control systems, in programming comments.
 - 4. Complete written narrative .of how each system is intended to operate.
- B. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition, any sub-system that the contractor is requesting for inclusion as substantial shall provide the O & M manuals for those sub-systems prior to issuance of the substantial completion for those sub-systems.
- C. In addition to the requirements specified in Division 1, include the following information for equipment items:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - 4. Servicing instructions and lubrication charts and schedules.

2. PRODUCTS

2.1 MATERIALS

- A. Unless otherwise specified, all materials and equipment shall be new, unused, and undamaged. Materials and equipment shall be the current designs and models of manufacturers regularly engaged in their production.

2.2 MATERIALS AND EQUIPMENT FURNISHED BY OTHERS

- A. Where materials and equipment are indicated as furnished by others and installed or connected under this contract, it shall be the Contractor's responsibility to verify installation details and requirements and make all necessary accommodations.

2.3 QUANTITY OF SPECIFIED ITEMS REQUIRED

- A. Wherever in the Contract Documents an item, device, or piece of equipment is referred to in the singular number, such reference shall apply to as many such articles as are shown on the drawings or required to complete the installation.

3. EXECUTION

3.1 JOBSITE SAFETY

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

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Store and handle material and equipment in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Use proper lifting equipment where size/weight requires handling by such means.
- D. Comply with manufacturer's rigging and moving instructions for unloading material and equipment, and moving them to final location.
- E. Equipment requiring disassembly for access purposes shall be disassembled and reassembled as required for movement into the final location following manufacturer's written instructions.
- F. Deliver material and equipment as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.
- G. Mechanical Contractor shall schedule deliveries so as to minimize space and time requirements for storage of materials and equipment on site.

- H. All piping is to be protected while stored for installation. Pipe ends are to be provided with pipe plugs, plastic wrap taped ends or pipe ends crimped closed. No exceptions. Piping found open will be tagged and prior to being installed by the contractor shall be cleaned, inspected by the owner representative and cleaning approved by the owner. Any pipe that has been installed without being approved by the owner shall be removed for visual inspection by the owner representative.
- I. Any material that is damaged during delivery, storage, handling, or installation shall be brought to the attention of the Architect/Engineer for review of its acceptability in the project.
 - 1. The Architect/Engineer shall be the sole and final judge as to the suitability of damaged items.

3.3 ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Refer to equipment specifications in Divisions 2 through 26 for rough-in requirements.

3.4 COORDINATION

- A. All mechanical rooms shall be constructed to maintain a minimum 3'-6" wide x 7'-6" high clearance between mechanical equipment and accessories. All trades shall coordinate work to provide this space.
- B. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
- C. Coordinate the mechanical work with work of the different trades so that:
 - 1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
 - 2. Within the limits indicated on the drawings, the maximum practicable space for operation, maintenance repair, removal and testing of mechanical and other equipment will be provided.
 - 3. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
 - a. Light fixtures.
 - b. Gravity flow piping, including steam and condensate.
 - c. Equipment requiring access, including terminal units, fire/smoke dampers, and piping valves.
 - d. Ductwork.
 - e. Electrical busduct.
 - f. Electrical cable trays, including access space.
 - g. Piping (hydronic and plumbing).
 - h. Sprinkler/standpipe piping.
 - i. Electrical conduits and wireway.

4. Pipes, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.
- E. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.

3.5 MECHANICAL INSTALLATIONS

- A. Verify all dimensions by field measurements.
- B. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
- C. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
- D. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- E. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Architect/Engineer.
- F. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
- G. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
- H. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
- I. Coordinate and the required electrical services and associated voltage, amps, phase etc. for all equipment and the associated factory and field installed control and power devices as required for complete and operable systems.

3.6 ACCESSIBILITY

- A. All work shall be installed so as to be accessible for operation, maintenance and repair with particular attention given to locating valves, controls and equipment requiring periodic lubrication, cleaning, adjusting or servicing of any kind.

3.7 LUBRICATION AND TOOLS

- A. Provide a fresh charge of lubricant in accordance with manufacturer's recommendations to all equipment requiring lubrication prior to start-up and maintain lubrication as required until acceptance by Owner.
 - 1. List lubricant type/weight of lubricant during last service prior to start/up on each unit so that owner can use same lubricant type as previously used by contractor.
- B. Provide for each piece of equipment any special tools and a list of such tools required for the operation or adjustment of the equipment and turn over to the Owner's representative prior to final acceptance of the equipment.

3.8 GENERAL CONTRACTOR – MECHANICAL EXTENT OF WORK

- A. Access Panels
 - 1. Furnish and install panels for access to valves and dampers and similar items where no other means of access, such as readily removable, sectional ceiling is shown or specified.
 - 2. The plans indicate the location of all anticipated access panels. The Division 23 Contractor shall make every effort to locate all material and equipment requiring service and maintenance above accessible ceilings or utilize the indicated access panels. Material and equipment requiring service and maintenance that is shown above inaccessible ceilings shall be relocated to accessible or exposed areas whenever possible. When these items are located in exposed areas, the Division 23 Contractor is to verify with the Architect/Engineer that the installation will not affect the aesthetics of the building. However, when it is not possible to locate these items in accessible or exposed areas due to the configuration of the actual installation of the mechanical and other trade systems or aesthetic reasons, additional access panels shall be provided. The contractor shall be equitably compensated for the additional access panels.

B. Cutting and Patching

1. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING." In addition to the requirements specified in Division 1, the following requirements apply:
2. The Division 23 Contractor shall coordinate all cutting and patching of holes, in existing building and new construction which are required for the passage of mechanical work.
3. Division 23 Contractor is to notify the General Contractor prior to submitting his bid, the number, size and location of all cutting and patching requirements. The Division 23 Contractor shall be liable for all associated costs of cutting and patching for mechanical work upon failure to notify the General Contractor prior to bid submission.
4. Under no circumstances shall any structural members, load-bearing walls or footings be cut without first obtaining written permission from the Engineer.
5. Cut, channel, chase and core drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
6. Patching of concrete openings shall be filled with grout and finished smooth with the adjacent surface.
7. All below-grade openings for pipe shall be sealed with interlocking synthetic rubber line assembly, Link-Seal by Thunderline Corporation or equal.
8. Repair cut surfaces to match adjacent surfaces.
9. Perform cutting, fitting, and patching of mechanical equipment and materials required to:
 - a. Uncover work to provide for installation of ill-timed work.
 - b. Remove and replace defective work.
 - c. Remove and replace work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

C. Excavation and Backfilling

1. Division 23 Contractor shall perform all excavation and backfilling necessary to install the required mechanical work. Coordinate the work with other excavating and backfilling work in the same area.
2. Except as indicated otherwise, comply with the applicable sections in Division 2 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
3. Trenching: Trench width shall be no more than required for shoring, bracing and performance of the work. All necessary shoring and bracing shall be installed to insure worker safety, proper installation of mechanical work, and protection of adjacent structures. Provide all dewatering as required. Depth shall not exceed that required to achieve the specified depth of cover and overdig will be permitted for bedding material only. All trenches shall be open cut from the surface.

4. Bedding: All work shall be properly bedded whether on virgin soil or on granular bedding as specified. All granular bedding shall be laid on undisturbed soil. PVC and copper piping shall have a 4" crushed stone bed conforming to specification for granular material in Division 2. If rock is encountered, excavate to a point 4" below installed bottom elevation of piping and provide bedding as called for above.
5. Haunching: Haunching shall be brought up on both sides of the pipe for a distance of 1/3 the pipe diameter and shall be of the same material used for bedding.
6. Backfill: Backfilling shall not begin until installation has been tested for leaks.
7. Final Backfill shall be as follows:
 - a. Outside Building Under Paved Areas: Granular material specified in Division 2.
 - b. Outside Building and Not Under Paved Areas: Clean soil free of vegetable matter and foreign material or crushed limestone. In planted areas backfill to a point 6" below finished grade. Owner will provide topsoil to finished grade.
8. Placement: Place all granular material in lifts of 12" maximum compacted to 100% of maximum dry density as determined as ASTM D698. Place soil in 6" lifts compacted to 95% of maximum density as determined by ASTM D698. Do not place any backfill until excavations have been cleaned of all water, debris and loose or soft soil.
9. Protection: At least 72 hours prior to excavating, for each phase, Contractor shall contact the Owner's Representative to arrange for utility locates in the construction area.
10. Contractor shall provide temporary supports for all underground utilities crossing an excavation.
11. Provide all required barricades, fencing, signs, lights, etc. as necessary for the protection of the workers and of the general public.
12. Excess Material: All excess earth and other material resulting from the excavation shall be removed from site daily by the Contractor.
13. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Mechanical Contractor.

D. Concrete Bases:

1. Minimum 4" high concrete housekeeping pads shall be provided under all floor-mounted mechanical equipment, regardless of whether explicitly shown on the Drawings. Concrete inertia pads with spring isolators shall be provided for all base-mounted pumps and air compressors installed on any floors which are not slab-on-grade. Inertia pads and isolators shall be sized by the equipment manufacturer if specific information is not provided in the Contract Documents.
2. Contractor shall verify, prior to submitting his bid, the number, size and location of all mechanical equipment bases.
3. Construct concrete equipment bases a minimum 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000 psi, 28-day compressive strength concrete, reinforcement and forms as specified in Division 3 Section "Cast-In-Place Concrete." Coordinate final equipment base size with General Contractor.
4. All equipment shall be mechanically fastened to concrete bases.

E. Roof curbs, roof support for mechanical equipment and roof penetrations.

1. Verify, prior to submitting bid, the number, size, and location of all roof curb and roof supports and the location of all roof penetrations. Provide all roof deck-mounted equipment, pipe supports, and pipe penetrations. Cut roof deck for pipe and duct penetrations, unless noted otherwise. Provide all roof covering/membrane mounted equipment and pipe supports and roof drains, unless noted otherwise.
2. Contractor shall be liable for all associated costs to install the roof curbs, roof supports and roof penetrations not shown on the roof plan or added after the roof system has been installed. Coordinate with the General Contractor prior to construction the number size and location of all roof penetrations.
3. All roof curbs, supports, and rails shall be sized to keep equipment a minimum of 18" above the roof insulation membrane in order to limit snow accumulation at or near equipment.

F. Painting

1. Field paint mechanical equipment and materials in specified areas as noted on the mechanical plans, mechanical schedules and in the specifications. Where items are to be painted, provide materials in these areas that are suitable for accepting paint. Clean and prepare the materials as necessary prior to painting, including removal of sharp edges. At minimum, items in these areas shall be painted:
 - a. Exposed items in areas other than mechanical rooms. Paint color shall match the adjacent surfaces (i.e. walls, ceilings, etc.) and shall follow the patterns of any adjacent accent colors.
 - 1) Items insulated with aluminum or stainless steel jackets are not required to be painted.
 - b. Concealed field-fabricated bare iron or steel items required for installation of work under this Division. Remove rough or sharp edges prior to painting.
 - c. Exposed field-fabricated bare iron or steel items required for installation of work under this Division. Remove rough or sharp edges prior to painting.
 - d. Exterior items which are not factory-painted. Paint color shall be selected by Architect.
2. Paint all items in accordance with Division 09 sections.

3.9 ELECTRICAL-MECHANICAL EXTENT OF WORK

- A. The responsibility of work specified under Division 23 and 26 is clarified under, Section 23 05 13, "Electrical Requirements for Mechanical Equipment. Division 23 Contractor is to coordinate all electrical requirements prior to ordering powered mechanical equipment.

END OF SECTION

PIPE PRESSURE TEST LOG											
PROJECT:											
BUILDING:						GENERAL CONTRACTOR:					
CLARK ENERSEN PROJECT NUMBER:						MECHANICAL CONTRACTOR:					
TEST INFORMATION						TEST PRESSURE					
TEST DATE	PIPI NG SYS TEM	AREA TESTED	TEST MEDIA (WATER OR AIR)	TEST DURATION (MINUTES)	PRESSURE GAGE NUMBER	INITIAL (PSIG)	FINAL (PSIG)	TESTED BY	WITNESSED BY	PASS / FAIL (P/F)	COMMENTS

ADDITIONAL

COMMENTS:

PRESSURE GAGE INFORMATION											
GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE	GAGE NUMBER	MANUFACTURER	PRESSURE RANGE	RESOLUTION	STYLE	DIAL SIZE

NOTE: USE MULTIPLE FORMS IF NECESSARY

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SECTION 23 05 13 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

1. GENERAL

1.1 SECTION INCLUDES

A. Electrical Requirements for:

1. Motors
2. Starters, Electrical Devices, and Wiring
3. Manual Motor Starters
4. Motor Connections
5. Capacitors
6. Safety Switches

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

A. Quality assurance.

1. Electrical components and materials shall be UL labeled and listed.

B. References.

1. The design, manufacture, testing and method of installation of all equipment and materials furnished under the requirements of this specification section shall conform to the following:
 - a. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - b. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
 - c. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
 - d. ANSI/NEMA Standard MG 1 – Motors and Generators.
 - e. ANSI/NFPA 70 - National Electrical Code.
 - f. NEMA Standard ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
 - g. NEMA Standard 250 – Enclosures for Electrical Equipment.
 - h. NEMA Standard KS 1 – Enclosed Switches.

C. Submittals.

1. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, or as required by the individual equipment specification sections.

D. Operation and maintenance manuals.

E. Project record documents.

F. Delivery, storage, and holding

G. Related sections.

1. Separate electrical components and materials required for field installation and electrical connections are specified in Division 26.

1.3 SUMMARY

- A. This section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory installed motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment. In addition, this section covers necessary coordination issues between mechanical and electrical disciplines. All mechanical and electrical construction documents must be completely reviewed by the Mechanical and Electrical Contractors prior to the submission of bids. Any discrepancies in the documents should be brought to the Architect/Engineer's attention at that time. Failure to properly coordinate or review documents in advance of submission of bids will not be valid cause for changes to the overall Contract amount.
- B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

2. PRODUCTS

2.1 MOTORS

- A. The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.
 1. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 2. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range. Minimum service factors shall be as follows:

Motor Service Factor Schedule		
Horsepower:	3600 RPM:	1800 RPM:
1/6 – 1/3	1.35	1.35
1/2	1.25	1.25
3/4	1.25	1.25
1 – 1.25	1.25	1.15
1.5 - 150	1.15	1.15

3. Two-speed poly-phase motors shall have two separate windings served by a single point electrical connection to the two speed starter. Two speed starters shall be located at the motor location unless otherwise noted.
4. Temperature Rating: Rated for 40 deg. C environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
5. Starting capability: Frequency of starts as indicated by automatic control system, and not less than five (5) evenly timed starts per hour for manually controlled motors.
6. Motor construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
 - a. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit each specific application.

- b. Bearings: Ball or roller bearings with inner and outer shaft seals; re-greasable; designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor; for fractional horsepower, light duty motors, sleeve type bearings are permitted.
 - c. Enclosure Type: Unless otherwise noted, use open drip-proof motors where satisfactorily housed or remotely located during operation; guarded drip-proof motors where exposed to contact by employees or building occupants; weather protected Type I for outdoor use, Type II where not housed.
 - d. Overload protection: Built-in thermal overload protection (in accordance with NEC requirements) and, where indicated, an internal sensing device suitable for signaling and stopping the motor at the starter.
- 7. Noise rating: "Quiet"
 - 8. Efficiency: **"Premium efficiency"** motors, as defined in NEMA MG 1, most recent edition.
 - 9. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.
 - 10. All three-phase motors shall be inverter duty type.
 - 11. Motors Used With Variable Frequency Drives: Ratings, characteristics, and features coordinated with and approved by drive manufacturer. Motor shall be designed and labeled for use with variable frequency drives. Motor shall be designed with critical vibration frequencies outside the operating range of the drive output and shall be suitable for use throughout speed range without overheating.
- a. Provide AEGIS SGR, or approved equivalent, shaft grounding ring/system to divert adverse shaft currents away from the motor bearings. Use AEGIS Colloidal Silver Shaft Coating (PN CS015), or approved equivalent, prior to ring installation. Install coating and ring per manufacturer recommendations.

2.2 SHEAVES

- A. All sheaves shall conform to NEMA Standard MG1-14.42, which lists minimum diameters and maximum overhangs. Locate motors to minimize overhang.
- B. When replacing sheaves, use sheaves of at least the originally supplied sizes.
- C. Contractor shall be responsible for replacement sheaves required to achieve specified performance. Coordinate with testing and balancing of the equipment.

2.3 STARTERS, ELECTRICAL DEVICES, AND WIRING

- A. Motor-Starter Characteristics: Motor starters shall be compatible with the equipment they serve. In general, motor starter characteristics shall meet the requirements of Division 26 specification sections and as outlined as follows:
- B. **Unless specifically approved in writing by the engineer, or as stated later in this paragraph, motor starters, VFDs and motor controllers (including equipment with integral motor starting) for motors shall have short circuit current ratings equivalent to the switchboard or electrical panel serving the load immediately upstream of the load. Refer to the electrical drawings for switchboard and electrical panel ratings. Provide additional overcurrent device protection if necessary to meet this requirement.**

1. **Exception: Where a motor or combination of motors is less than 10 horsepower in total and fed by more than 50 feet of wiring between the switchboard or panel that it is served by and the motor starter/controller/VFD, the starter/controller/VFD may have a short circuit current rating of 5000 Amps.**

C. Motor Connections

1. Provide connections to motors in accordance with the requirements listed in the electrical specifications.
2. See Division 26 for the use of lugs for motor connections.

D. Capacitors

1. Capacitor features shall include:
 - a. Individual unit cells.
 - b. All welded steel housing.
 - c. Each capacitor shall be internally fused.
 - d. Non-flammable synthetic liquid impregnate.
 - e. Craft tissue insulation.
 - f. Aluminum foil electrodes
2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

E. FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

F. FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

1. See specification section 26 29 13 – Motor Controllers for requirements.

G. MANUAL MOTOR STARTERS

- H. See specification section 26 29 13 – Motor Controllers for requirements.

I. CAPACITORS

1. Capacitor features shall include:
 - a. Individual unit cells.
 - b. All welded steel housing.
 - c. Each capacitor shall be internally fused.
 - d. Non-flammable synthetic liquid impregnate.
 - e. Craft tissue insulation.
 - f. Aluminum foil electrodes

2. KVAR size shall be determined by the Contractor/Supplier and shall correct motor power factor to 95 percent or better and shall be installed on all motors 10 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load. Power factor correction is not required for motors used in conjunction with variable frequency drives.

2.4 SAFETY SWITCHES

- A. See specification section 26 05 01 – Basic Electrical Materials and Methods.

3. EXECUTION

3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.
- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

3.2 CONTRACTOR COORDINATION

- A. General contractor is responsible for coordination of all subcontractors and associated scopes of work.

END OF SECTION

SECTION 23 05 19 – HVAC METERS AND GAGES

1. GENERAL

1.1 SECTION INCLUDES

- A. Static pressure and filter gages.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References
- C. Submittals
 - 1. Product Data: For each type of product.
 - a. Include diagrams for power, signal, and control wiring.
- D. Operation and maintenance manuals.
- E. Project record documents
 - 1. Accurately record actual locations of instrumentation.
- F. Delivery, storage, and handling

1.3 ENVIRONMENTAL REQUIREMENTS

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

2. PRODUCTS

2.1 STATIC PRESSURE GAGES

- A. Inclined manometer, red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.
- B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.
- C. Construction: Bronze or stainless-steel body, with sight glass and [ball, flapper, or paddle wheel] <Insert device> indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: [125 psig (860 kPa)] [150 psig (1034 kPa)] <Insert value>.

- E. Minimum Temperature Rating: [200 deg F (93 deg C)] <Insert temperature>.
- F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

3. EXECUTION

3.1 GENERAL

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

3.2 TEST PLUGS

- A. Test Plugs: Install where indicated, located on pipe at most readable position. Secure cap.

3.3 ADJUSTING AND CLEANING

- A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.
- B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 05 29 – HVAC HANGERS AND SUPPORTS

1. GENERAL

1.1 SECTION INCLUDES

- A. Pipe, ductwork, and equipment hangers, supports, anchors, saddles and shields.
- B. Mechanical flashing.
- C. Equipment curbs.
- D. Mechanical sleeves and seals.
- E. Flashing and sealing equipment and pipe stacks.
- F. Sealants, firestop insulation, putty and compounds.
- G. Pipe Stands
- H. Related Requirements:
 - 1. Section 05 50 00 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
 - 2. Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Hanger, Support, and Attachment Schedule: Include hanger, support, and attachment schedule that includes pipe system, pipe sizes, hanger, support, and attachment type.
- C. Detail application of protective shields, saddles, and inserts at hangers for each type of pipe/insulation and hanger.
- D. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.

- E. Delegated Design Submittals: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- 1. Detail fabrication and assembly of trapeze hangers.
- 2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

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

1.5 PERFORMANCE REQUIREMENTS

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

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References.
- C. Submittals.
- D. Operation and maintenance manuals.
- E. Project record documents.
- F. Delivery, storage, and handling.

2. PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

A. Hydronic Piping:

1. Conform to International Mechanical Code, ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89 as applicable.

B. Refrigerant Piping

1. Conform to International Mechanical Code, ASME B31.1, ASTM F708, MSS SP58, MSS SP69, MSS SP89, as applicable.

C. Hangers and Supports:

1. Hangers for Hot and Cold Pipe Sizes 1/2 to 1-1/2 Inch, Carbon steel, adjustable swivel, band type.
2. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
3. Hangers for Hot Pipe Sizes 2 to 4 Inches; Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.
5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
6. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
7. Wall Support for Hot Pipe Sizes 6 Inches (150 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
9. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.
10. Vertical Support: Steel riser clamp.
11. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
12. 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.
13. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
14. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
15. Roof Support for Hot and Cold Pipe: See PIPE STANDS section below.
- 16. Hangers for insulated pipe shall be enlarged to compensate for insulation thickness so that hangers support insulation. See Section 23 07 19.**
17. See Section 23 05 48 for vibration isolation hangers and supports if applicable.

2.2 DUCTWORK HANGERS AND SUPPORTS

- A. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," [Table 5-1 \(Table 5-1M\)](#), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- B. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- C. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports:
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Exposed Stainless-Steel Ducts: Stainless-steel shapes and plates.

2.3 ACCESSORIES

- A. Hanger Rods: ASTM A36 steel or galvanized threaded both ends, threaded one end, or continuous threaded.
 - 1. Ductwork: Use double nuts and lock washers on threaded rod supports.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Internally Threaded Screw Anchors: Internally threaded, self tapping screw anchors, Power Fasteners Snake or approved equivalent.
 - 1. Tested in accordance with ACI 355.2 and ICC-ES AC193 for use in structural concrete under the design provisions of ACI318 (Strength Design method using Appendix D)

2.5 INSERTS

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

2.6 FLASHING

- A. Metal Flashing: 26 gage galvanized steel.
- B. Metal Counterflashing: 22 gage 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 buty; compatible with roofing.

- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.7 EQUIPMENT CURBS

- A. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer. Minimum 18 inch height, unless specified otherwise.
 - 1. Refer to specification section 23 74 00 – Packaged Outdoor HVAC Equipment for RTU-1 curb information.

2.8 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage galvanized steel.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.

2.9 SEALANTS, FIRESTOP INSULATION, PUTTY, AND COMPOUNDS

- A. Firestopping Insulation: Glass fiber type, non-combustible, UL listed.
- B. Firestop Putty: Non-hardening, non shrinking, UL listed.
- C. Firestop Compounds: Cementitious material, non-shrinking, UL listed.
- D. Sealants:
 - 1. Non fire/smoke rated partitions: Acrylic or silicone based caulking.
 - 2. Fire/smoke rated partitions: Silicone based caulking, UL listed.

2.10 PIPE STANDS (ROOF)

- A. General Requirements for Pipe Stands: Shop or field –fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Plastic

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel with plastic or stainless-steel, roller-type pipe support.

D. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of Bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal member: Protective-coated-steel channel.
5. Pipe Supports: galvanized-steel, clevis-type pipe hangers.

E. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

3. EXECUTION

3.1 INSTALLATION

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

3.2 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- 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.

3.3 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Support fire protection systems piping independently from other piping systems. Fire main piping may be trapezed with other piping systems. Coordinate trapeze hangers with the Sprinkler Contractor.
 1. Reference sections 21 05 29 and 22 05 29 for additional information regarding fire protection and plumbing piping supports and hangers.
- C. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- H. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide copper plated hangers and supports for non-insulated copper pipe.
- K. Design hangers for pipe movement without disengagement of supported pipe.
- L. Prime coat steel hangers and supports in the mechanical room and other exposed areas. Refer to the Architectural reflected ceiling plans for location of exposed ceilings. Hangers and supports located in attic space, crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Adjust hangers to distribute loads equally on attachments and to achieve specified pipe slopes.
- N. Saddles, Shields and Inserts
 - 1. Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
 - 2. Install protective shields MSS Type 40 on cold piping that has vapor barrier. Shields shall span an arc of 180 degrees (360 degrees on trapeze hangers with U-bolt clamps) and shall have dimensions in inches not less than the following:

<u>NPS</u>	<u>LENGTH</u>	<u>THICKNESS</u>
1 through 3-1/2	12	0.048
4	12	0.060
5 & 6	18	0.060
8 through 14	24	0.075
16 through 24	24	0.105
 - 3. Pipes 8 inches and larger shall have wood inserts.
 - 4. Insert materials shall be at least as long as the protective shield.
 - 5. Provide manufacturer-recommended saddles, inserts, and/or shields where cellular foam insulation is used. The removal of sections of cellular foam insulation for the purpose of pipe support is not acceptable.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 - 1. Where practical, install concrete inserts before placing concrete.
 - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.
- D. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.6 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls and floors.
- B. Flash drains in floors with topping over finished area with lead, inches clear on sides with minimum 36 x 36 inch sheet size. Fasten to drain clamp device.
- C. Seal floor, shower, mop sink, etc. drains watertight to adjacent materials.

- D. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
- E. 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.

3.7 SLEEVES

- A. Provide pipe and duct sleeves at all fire/smoke rated partitions, exterior wall penetrations and wall penetrations into exposed areas. Pipe and duct sleeves are not required for penetrations through non-rated concealed partitions.
- B. At the Contractor's option, pipe sleeves may be omitted if the wall or floor is core drilled.
- C. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Sleeves through floors shall be grinded flush with finish floor level.
- F. Where piping or ductwork penetrate non-rated ceilings or walls, close off space between pipe or duct and adjacent work with urethane rod stock and caulk air tight.
- G. Seal pipe and duct penetrations through non-rated floors.
 - 1. Where piping is not located in a rated shaft and it penetrates a single non-rated floor, close off space between pipe and adjacent work with urethane rod stock and caulk air tight.
 - 2. Where piping is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between pipe and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
 - 3. Where ductwork is not located in a rated shaft and it penetrates a single non-rated floor, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound.
 - 4. Where ductwork is not located in a rated shaft and it penetrates multiple non-rated floors, close off space between duct and adjacent work with appropriate fire-rated sealant, insulation, putty, or compound. Install fire damper in duct at each floor level. Ductwork containing fume exhaust air shall not be provided with fire dampers.
- H. Where piping or ductwork penetrate rated floor, ceiling, or wall, close off space between pipe or duct with appropriate fire rated sealant, insulation, putty or compound. Refer to the Drawings for fire/smoke rated wall locations and the appropriate ratings.
- I. Provide on ductwork close fitting metal collar or escutcheon covers on the side of penetration that are exposed to view.
- J. Install chrome plated steel escutcheons on piping at finished surfaces.
- K. Provide mechanical seals and sleeves through exterior wall and floor penetrations and 3 hour or higher fire rated partitions.

3.8 HANGER SCHEDULES

- A. Install hangers for with maximum horizontal and vertical spacing and minimum rod diameters, to comply with MSS SP-58, International Plumbing and Mechanical Code, seismic restraint requirements, manufacturer requirements, and authorities having jurisdiction requirements, whichever are most stringent. The following maximum horizontal and vertical piping support spacings shall be used unless a more stringent requirement is needed:

B. PIPING SUPPORT SPACING SCHEDULE

PIPING MATERIAL ^a	MAX. HORIZONTAL SPACING (ft.):	MAX. VERTICAL SPACING (ft.):
ABS pipe	4	10 ^c
Aluminum pipe and tubing	10	15
Cast-iron pipe ^b	5	15
Copper or copper-alloy pipe	12	10
Copper or copper-alloy tubing	8	10
CPVC pipe or tubing, 1 inch and smaller	3	10 ^c
CPVC pipe or tubing, 1-1/4 inch and larger	4	10 ^c
Lead pipe	Continuous	4
PB pipe or tubing	32 inches	4
PE-RT 1 inch and smaller	32 inches	10 ^c
PE-RT 1-1/4 inch and larger	4	10 ^c
PEX tubing 1 inch and smaller	32 inches	10 ^c
PEX 1-1/4 inch and larger	4	10 ^c
Polypropylene (PP) pipe or tubing, 1 inch and smaller	32 inches	10 ^c
Polypropylene (PP) pipe or tubing, 1-1/4 inch and larger	4	10 ^c
PVC pipe	4	10 ^c
Steel tubing	8	10
Steel pipe	12	15

PIPING SUPPORT SPACING SCHEDULE NOTES:

- a: Refer to International Mechanical Code for additional requirements.
- b: The maximum horizontal spacing of cast-iron pipe hangers shall be increased to 10 feet where 10-foot lengths of pipe are installed.
- c: Mid-story guide.

END OF SECTION

SECTION 23 05 48 - SEISMIC AND VIBRATION ISOLATION CONTROLS FOR HVAC, PLUMBING, AND ELECTRICAL BUILDING SYSTEMS

1. GENERAL

1.1 ADMINISTRATIVE REQUIREMENTS

- A. The Contractor shall be responsible for determining the requirements for seismic control measures to be applied to mechanical equipment and distribution, electrical conduit and raceways, electrical switchgear and plumbing systems specified herein. Seismic protection criteria use to determine seismic control requirements of all mechanical, electrical, and plumbing systems shall be determined by the applicable code adopted in the project jurisdiction. Where not already determined within the contract documents, the Contractor shall be responsible for contracting a licensed professional engineer to establish building site class, seismic use group, occupancy category, seismic zone or any other criteria necessary to determine the requirements for seismic control measures for mechanical, electrical, and/or plumbing systems.

1.2 DESCRIPTION

A. Intent

1. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
2. **All isolators and isolation materials shall be supplied by the same manufacturer and shall be certified by the manufacturer.**
3. It is the intent of the seismic portion of this specification to keep mechanical, plumbing, and electrical building system components bearing a Component Importance Factor of $I_p=1.5$ in place during a seismic event. All other non-structural components assigned a Component Importance Factor, $I_p = 1.0$ shall be exempt from the requirements of the seismic portion of this specification. Refer to the following specification sections for more information:
 - a. Rooftop Unit(s) – Refer to specification section 23 74 00 “Packaged Outdoor HVAC Equipment”
 - b. Exhaust fan(s) – Refer to specification section 23 42 23 “Power Ventilators”
 - c. Ductwork – Refer to specification section 23 31 13 “Ductwork”
 - d. Plumbing piping – Refer to specification section 22 10 00 “Plumbing Piping”
 - e. Natural gas piping – Refer to specification section 22 10 00 “Plumbing Piping”
 - f. Water heater(s) – Refer to specification section 22 30 00 “Plumbing Equipment”
 - g. Backflow preventer(s) – Refer to specification section 22 11 19 “Plumbing Specialties”
 - h. Safety Switches, Boxes, Supports -- Refer to specification section 26 05 01 “Basic Materials and Methods”
 - i. Conductors -- Refer to specification section 26 05 19 “Conductors”
 - j. Raceways -- Refer to specification section 26 05 33 “Raceways”
 - k. Dry-Type Transformers – Refer to specification section 26 22 00 “Dry-Type Transformers”
 - l. Panelboards -- Refer to specification section 26 24 16 “Panelboards”
 - m. Wiring Devices – Refer to specification section 26 27 26 “Wiring Devices”

- n. Motor Controllers -- Refer to specification section 26 29 13 "Motor Controllers"
 - o. Light Fixtures, Exit Signs, Egress Lighting -- Refer to specification section 26 51 00 "Lighting"
 - p. Fire Alarm System -- Refer to specification section 28 31 11 "Addressable Fire Alarm System"
4. All such systems must be installed in strict accordance with seismic codes, component manufacturer's and building construction standards. Whenever a conflict occurs between the manufacturer's or construction standards, the most stringent shall apply.
 5. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).
 6. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
 7. Seismic restraints shall be designed in accordance with seismic force levels as detailed in section 1.4
- B. The work in this section includes, but is not limited to the following:
1. Vibration isolation for piping, ductwork, and equipment (both mechanical and electrical).
 2. Equipment isolation bases.
 3. Flexible piping connections.
 4. Resilient Pipe Anchors and Guides.
 5. Seismic restraints for isolated equipment.
 6. Seismic restraints for non-isolated equipment.
 7. Certification of seismic restraint designs and installation supervision.
 8. Certification of seismic attachment of housekeeping pads.
 9. All mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included.
- C. Definitions
1. Life Safety Systems:
 - a. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire alarm systems, fire dampers and smoke exhaust systems.
 - b. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all flowpaths to fire protection/fire alarm and/or emergency lighting systems.
 - c. All medical and life support systems.
 - d. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.
 2. Positive Attachment:
 - a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable

trays, or any other equipment are not acceptable on this project as seismic attachment points.

3. Transverse Bracing:

- a. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

4. Longitudinal Bracing:

- a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.3 CODES AND STANDARD REQUIREMENTS

A. Refer to CURRENTLY ADOPTED AND APPLICABLE CODES on Summary Code Plan on Drawings.

- 1. 2021 International Building Code (IBC)

B. Refer to DESIGN CRITERIA on Structural Drawings.

1.4 SUBMITTAL DATA REQUIREMENTS

A. Seismic Control Measure Analysis: The Contractor shall provide an analysis determining the requirements or exemption for seismic control measures for mechanical, electrical, and plumbing equipment. The analysis shall be signed and sealed by a licensed professional structural engineer.

- 1. The analysis shall at a minimum include the following:

- a. For projects permitted under International Building Code:

- 1) Seismic Use Group or Building Category
 - 2) Seismic Design Category
 - 3) Site Class
 - 4) Design Spectral Response Acceleration Values

- b. For projects with equipment mounted outdoors and subject to wind restraint requirements:

- 1) Basic Wind Speed.
 - 2) Building Classification Category
 - 3) Minimum 10lb/sq.ft. multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction and 45 degrees either side of normal.

B. The manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

- 1. Descriptive Data:

- a. Detailed schedules of flexibly and rigidly mounted equipment, showing vibration isolators and seismic restraints, referencing numbered descriptive drawings.
- b. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.

2. Shop Drawings:

- a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
- b. Submit details of isolation hangers for ceiling hung equipment, piping and ductwork.
- c. Submit details of mountings for floor supported equipment, piping and ductwork.
- d. All hanger, mounting or pad drawings shall indicate deflections and model numbers as well as any other requirements in the specifications.
- e. Spring diameters, rated loads and deflections, heights at rated load and closed height shall be provided for all springs shown in the submittals in tabular form.
- f. Complete flexible connector details.
- g. Specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
- h. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.

3. Seismic Certification and Analysis:

- a. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job locations.
- b. All restraining devices shall have a preapproval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Preapprovals based on independent testing are preferred to preapprovals based on calculations. Where preapproved devices are not available, submittals based on independent testing are preferred. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
- c. Analysis must include calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces detailed in section 1.4 acting throughout the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.5 SEISMIC FORCE LEVELS

A. Refer to Seismic Load Criteria on Structural Drawings of contract documents for:

- 1. Risk Category
- 2. Seismic Importance Factor

3. Mapped Spectral Response
4. Site Class
5. Design Spectral Response
6. Seismic Design Category
7. Basic Seismic Force Resisting System (SFRS)
8. Design Base Shear
9. Seismic Response Coefficient
10. Response Modification Factor
11. Analysis Procedure Used

B. The following force levels will be used on this project

		"G" Forces for High Deformability Pipe, Bus Ducts, Conduits & Cabletrays $a_p^*=1.0, R_p^*=3.5$		"G" Forces for Rigidly Mounted Equipment & Limited Deformability Pipe $a_p^*=1.0, R_p^*=2.5$		"G" Forces for Vibration Isolated Equipment & Pipe Pressure Vessels $a_p^*=2.5, R_p^*=2.5$		"G" Forces for Low Deformability Pipe $a_p^*=1.0, R_p^*=1.25$	
		Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.	Horiz.	Vert.
Lower Levels and Ground Level	Ss less than 0.15	0.08	0.05	0.08	0.05	0.10	0.05	0.08	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.13	0.08	0.17	0.08	0.13	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.17	0.11	0.23	0.11	0.18	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.22	0.15	0.29	0.15	0.23	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.30	0.20	0.40	0.20	0.32	0.20
	Ss greater than 1.50	0.50	0.33	0.50	0.33	0.67	0.33	0.53	0.33
Above Ground Level up to 1/4 of the Height of Building	Ss less than 0.15	0.08	0.05	0.08	0.05	0.15	0.05	0.12	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.13	0.08	0.25	0.08	0.20	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.17	0.11	0.34	0.11	0.27	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.22	0.15	0.44	0.15	0.35	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.30	0.20	0.60	0.20	0.48	0.20
	Ss greater than 1.50	0.50	0.33	0.50	0.33	1.00	0.33	0.80	0.33
Above 1/4 up to 1/2 of the Height of the Building	Ss less than 0.15	0.08	0.05	0.08	0.05	0.20	0.05	0.16	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.13	0.08	0.34	0.08	0.27	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.18	0.11	0.46	0.11	0.36	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.23	0.15	0.58	0.15	0.47	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.32	0.20	0.80	0.20	0.64	0.20
	Ss greater than 1.50	0.50	0.33	0.53	0.33	1.34	0.33	1.07	0.33
Above 1/2 up to 3/4 of the Height of the Building	Ss less than 0.15	0.08	0.05	0.10	0.05	0.25	0.05	0.20	0.05
	Ss between 0.15 & 0.25	0.13	0.08	0.17	0.08	0.42	0.08	0.34	0.08
	Ss between 0.26 & 0.50	0.17	0.11	0.23	0.11	0.57	0.11	0.46	0.11
	Ss between 0.51 & 1.00	0.22	0.15	0.29	0.15	0.73	0.15	0.58	0.15
	Ss between 1.01 & 1.50	0.30	0.20	0.40	0.20	1.00	0.20	0.80	0.20
	Ss greater than 1.50	0.50	0.33	0.67	0.33	1.67	0.33	1.34	0.33
Above 3/4 of the Height of Building up to the Roof	Ss less than 0.15	0.09	0.05	0.12	0.05	0.30	0.05	0.24	0.05
	Ss between 0.15 & 0.25	0.14	0.08	0.20	0.08	0.50	0.08	0.40	0.08
	Ss between 0.26 & 0.50	0.20	0.11	0.27	0.11	0.68	0.11	0.54	0.11
	Ss between 0.51 & 1.00	0.25	0.15	0.35	0.15	0.88	0.15	0.70	0.15
	Ss between 1.01 & 1.50	0.34	0.20	0.48	0.20	1.20	0.20	0.96	0.20
	Ss greater than 1.50	0.57	0.33	0.80	0.33	2.00	0.33	1.60	0.33

1.6 MANUFACTURER'S RESPONSIBILITY

- A. Manufacturer of vibration isolation and seismic restraint equipment shall have the following responsibilities
1. Determine vibration isolation and seismic restraint size and location.
 2. Provide vibration isolation and seismic restraint as scheduled or specified.
 3. Provide calculations and materials if required for restraint of unisolated equipment

4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.7 RELATED WORK

A. Housekeeping Pads

1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

C. Attachments

1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

2. PRODUCTS

2.1 INTENT

- A. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. Mason Industries' products are the basis of these specifications; products of other manufacturers will be considered provided samples strictly comply with the specification and have the approval of the specifying engineer. Submittals and certification sheets shall be in accordance with section 1.3.
- B. For purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8" and/or horizontal permanent deformation greater than 1/4".

2.2 PRODUCT DESCRIPTION (Each product is given a letter designated paragraph; product details are provided at the end of this section. Application of products to be as scheduled in Part 4.)

1. Two layers of 3/4" (19mm) thick neoprene pad consisting of 2" (50mm) square waffle modules separated horizontally by a 16 (1.5mm) gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be type Super "W" as manufactured by Mason Industries, Inc.

2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" (5mm) and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be type BR as manufactured by Mason Industries, Inc.
3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" (6mm) neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLF as manufactured by Mason Industries, Inc.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Restraining Bolts shall have a neoprene bushing between the bolt and the housing. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "OPA" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be type SLR or SLRS as manufactured by Mason Industries, Inc.
7. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" (6mm) travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval "OPA" number from OSHPD in the State of California
8. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" (3mm). Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air Springs shall be type MT and leveling valves type LV as manufactured by Mason Industries, Inc.

9. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" (12mm) shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be type SLR-MT as manufactured by Mason Industries, Inc.
10. Hangers shall consist of rigid steel frames containing minimum 1 1/4" (32mm) thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
- 10A. Hangers shall be as described in 10, but they shall be supplied with a combination rubber and steel rebound washer as the seismic upstop for suspended piping, ductwork, equipment and electrical cabletrays. Rubber thickness shall be a minimum of 1/4" (6mm). Submittals shall include a drawing of the hanger showing the installation of the rebound washer. Hangers shall be type RW30N as manufactured by Mason Industries, Inc.
11. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cables must be prestretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.
13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage preapproval "OPA" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB, SSBS or SSRF as manufactured by Mason Industries, Inc.

Note: Specifications 12 - 14 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.

14. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.
15. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
16. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4" (6mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm²) A minimum air gap of 1/8" (3mm) shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be type Z-1225 as manufactured by Mason Industries, Inc.
17. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" (19mm) thick. Rated loadings shall not exceed 1000 psi (.7kg/mm²). Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" (3mm) nor more than 1/4" (6mm). Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" (9mm) deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" (12mm) deflection in the x, y and z planes. Snubbers shall have an anchorage preapproval "OPA" number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be type Z-1011 as manufactured by Mason Industries, Inc.
18. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
19. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
20. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14" (350mm) provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1" (25mm). Bases shall be type WF as manufactured by Mason Industries, Inc.

21. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6" (150mm). The base depth need not exceed 12" (300mm) unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" (12mm) bars welded in place on 6" (150mm) centers running both ways in a layer 11/2" (38mm) above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1" (25mm) clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
22. Curb mounted rooftop equipment shall be mounted on spring isolation curbs. The lower member shall consist of a sheet metal or structural steel sections containing adjustable and removable steel springs that support the upper floating section. The upper frame must provide continuous support for the equipment and must be captive so as to resiliently resist wind and seismic forces. All directional neoprene snubber bushings shall be a minimum of 1/4" (6mm) thick. Steel springs shall be laterally stable and rest on 1/4" (6mm) thick neoprene acoustical pads. Hardware must be plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous flexible flashing nailed over the lower curbs waterproofing. All spring locations shall have accessibility to adjust springs. Lower curbs shall have provision for 2" (50mm) of insulation. The roof curbs shall be built to seismically contain the rooftop unit. The unit must be solidly fastened to the top floating rail, and the lower section anchored to the roof structure. Curb shall have anchorage preapproval "OPA" from OSHPD in the state of California attesting to the maximum certified horizontal and vertical load ratings. Curb shall be type SRSC or RMSS as manufactured by Mason Industries, Inc.
23. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Kevlar ® tire cord frictioning. Any substitutions must have equal or superior physical and chemical characteristics. Solid steel rings shall be used within the raised face rubber flanged ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" (50mm) and larger shall have two spheres reinforced with a ductile iron external ring between spheres. Flanges shall be split ductile iron or steel with hooked or similar interlocks. Sizes 16" (400mm) to 24" (600mm) may be single sphere. Sizes 3/4" (19mm) to 1 1/2" (38mm) may have threaded two piece bolted flange assemblies, one sphere and cable retention. Connectors shall be rated at 250 psi (1.72MPa) up to 170°F (77°C) with a uniform drop in allowable pressure to 215 psi (1.48MPa) at 250°F (121°C) in sizes through 14" (350mm). 16" (400mm) through 24" (600mm) single sphere minimum ratings are 180 psi (1.24MPa) at 170°F (77°C) and 150 psi (1.03MPa) at 250°F (121°C). Higher rated connectors may be used to accommodate service conditions. All expansion joints must be factory tested to 150% of rated pressure for 12 minutes before shipment. Safety factors to burst and flange pullout shall be a minimum of 3/1. Concentric reducers to the above ratings may be substituted for equal ended expansion joints.

Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods. If control rods are used, they must have 1/2" (12mm) thick Neoprene washer bushings large enough in diameter to take the thrust at 1000 psi (.7 kg/mm²) maximum on the washer area.

Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be type SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

24. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75mm) and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

FLANGED

3" x 14" (75 x 350mm)	6" x 20" (150 x 500mm)	12" x 28" (300 x 700mm)
4" x 15" (100 x 375mm)	8" x 22" (200 x 550mm)	14" x 30" (350 x 750mm)
5" x 19" (125 x 475mm)	10" x 26" (250 x 650mm)	16" x 32" (400 x 800mm)

MALE NIPPLES

1/2" X 9" (12 X 225mm)	1 1/4" x 12" (32 x 300mm)	2" x 14" (50 x 350mm)
3/4" x 10" (19 x 250mm)	1 1/2" x 13" (38 x 325mm)	2 1/2" x 18" (64 x 450mm)
1" x 11" (25 x 275mm)		

Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm²) and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
26. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" (12mm) thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of ±15/8" (41mm) motion, or to meet location requirements. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.
27. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" (19mm) thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" (25mm) past either face of the wall. Where temperatures exceed 240°F(115°C), 10# (4.5kg) density fiberglass may be used in lieu of the sponge. Seals shall be type SWS as manufactured by Mason Industries, Inc.
28. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" (6mm) movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

29. Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top. The upper portion shall have holes for rebar to pass through. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor. Housekeeping pad anchors shall be type HPA and stud wedge anchor shall be type SAS both as manufactured by Mason Industries, Inc.

3. EXECUTION

3.1 GENERAL

- A. All vibration isolators and seismic restrains systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architect's/engineer's attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- G. Bring to the architect's/engineer's attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.
- I. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed 2.02-O capabilities.
- J. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide 2.02-Q seals.
- K. Locate isolation hangers as near to the overhead support structure as possible.
- L. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust when thrust forces exceed 10% of the equipment weight. Horizontal thrust restraints shall be 2.02-I restraints.

- M. Rooftop equipment isolators must be bolted to the equipment and structure. Mountings must be designed to resist 120m/h wind loads.
- N. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- O. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
- P. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.
- Q. At locations where specification 12 cable restraints are installed on support rods with spring isolators, the spring isolation hangers must be specification type 10A.
- R. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.
- S. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 female wedge type for floor mounted equipment.
- T. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
- U. All mechanical equipment shall be vibration isolated and seismically restrained as per the schedules in part 4 of this specification.

3.2 VIBRATION ISOLATION OF PIPING

- A. Horizontal pipe isolation: The first four pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10 & 10A. Floor supported piping shall rest on isolators as described in specification 6. Heat exchangers and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Hanger locations that also have seismic restraints attached must have type RW Rebound Washers to limit uplift. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Riser isolation: Risers shall be suspended from specification 10A hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to $\pm 25\%$ of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.

C. Seismic Restraint of Piping.

1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables if isolated. Specification 12 or 13 restraints may be used on unisolated piping.
 - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping that is 1" (25mm) I.D. or larger.
 - b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1¼" (32mm) I.D. and larger.
 - c. All other piping 2½" (64mm) diameter and larger.
2. Transverse piping restraints shall be at 40' (12m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' (24m) maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints must be at 20' (6m) maximum and longitudinal restraints at 40' (12m) maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" (600mm) of the elbow or TEE or combined stresses are within allowable limits at longer distances. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
7. Branch lines may not be used to restrain main lines.
8. Cast iron pipe of all types, glass pipe and any other pipes joined with a four band shield and clamp assembly in areas with S_s of 0.35 or greater shall be braced as in sections 3.02.C.2 and 3. For areas with S_s less than 0.35, 2 band clamps may be used with a reduced spacing of 1/2 of those listed in sections 3.02.C.2 and 3.
9. Connection to the structure must be made with a non-friction connection (i.e. no "C" clamps)
10. Hanger locations that also have seismic restraints attached must have Specification 10A type RW Rebound Washers.

D. Pipe Exclusions

1. Gas piping less than 1" (25mm) inside diameter.
2. Piping in oiler and mechanical rooms less than 1¼" (32mm) inside diameter
3. All other piping less than 2 ½" (64mm) inside diameter.
4. All piping suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less.
5. All trapezed piping where the distance from the suspension point to the trapeze member is 12" or less.

6. If any suspension location in the run exceeds the above, the entire run must be braced.

3.3 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF DUCTWORK

A. Vibration isolation of ductwork

1. All discharge runs for a distance of 50' (15m) from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75" (19mm).
2. All duct runs having air velocity of 1000 fpm (5 m/s) or more shall be isolated from the building structure by specification 11 hangers or 5 floor supports. Spring deflection shall be a minimum of 0.75" (19mm).

B. Seismic restraint of ductwork

1. Seismically restrain all ductwork with specification 12 or 13 restraints as listed below:
 - a. Restrain rectangular ducts with cross sectional area of 6 sq.ft. (.5 m²) or larger.
 - b. Restrain round ducts with diameters of 28" (700mm) or larger.
 - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30' (9mm) intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' (1.2m) of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
4. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
5. Walls, including gypsum board non bearing partitions, which have ducts running through them may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.
6. Connection to the structure must be made with a non-friction connection (i.e. no "C" clamps)
7. Hanger locations that also have seismic restraints attached must have Specification 10A type RW Rebound Washers.

C. Ductwork Exclusions

1. Rectangular or square ducts that are less than 6 square feet in cross sectional area.
2. Oval ducts that are less than 6 square feet (0.5m²) in cross sectional area based on nominal size.
3. Round duct less than 28" (0.71m) in diameter
4. All trapezed ductwork where the distance from the suspension point to the trapeze member is 12" or less.

5. Ductwork hung from straps where the top of the duct is 12" or less from the suspension point and the strap has 2 #10 sheet metal screws within 2" of the top of the duct.
6. If any suspension location in the run exceeds the above, the entire run must be braced.

3.4 ELECTRICAL SERVICES

A. Seismic Restraint

1. All electrical conduit 2 1/2" (64mm) in diameter and larger shall be restrained with specification type 12 seismic cable restraints or specification type 13 for seismic solid brace restraints.
2. All electrical bus ducts, cable trays and ladder trays shall be restrained with specification type 12, seismic cable restraints or specification 13 seismic solid brace restraints.
3. Transverse restraints shall occur at 30' (9m) intervals or both ends if the electrical run is less than the specified interval. Transverse restraints shall be installed at each electrical services turn and at each end of the electric run.
4. Longitudinal restraints shall occur at 60' (18m) intervals with at least one restraint per electric run. Transverse restraints for one electric section may also act as a longitudinal restraint for a duct for an electric section connected perpendicular to it if the restraints are installed within 4' (1.2m) of the intersection of the electric run and if the restraints are sized for the larger electric run.
5. All floor mounted transformers, motor starters, switchgears and substations must have a resilient media between the equipment mounting hole and the anchor bolt. Anchor bolts shall be designed in accordance with section 1.06 seismic forces. Neoprene bushings shall be specification type 4 and anchor bolts shall be specification type 18 or 19.
6. Wall mounted panels, transformers and motor starters shall be mounted with specification type 3 bushings. Floor mounted panels shall be mounted on specification type 4 bushings.
7. Anchor bolts shall be specification type 18 or 19.
8. All generators shall be mounted on a Specification type 21 concrete inertia base, with
9. Specification type 5 spring isolators and Specification type 17 seismic snubbers.
10. Connection to the structure must be made with a non-friction connection (i.e. no "C" clamps)

B. Exclusions

1. All conduit less than 2 1/2" (64mm) diameter suspended by individual hanger rods.
2. All conduits suspended by clevis hangers where the distance from the top of the pipe to the suspension point is 12" or less.
3. All trapezed conduits, bus ducts and cable trays where the distance from the suspension point to the trapeze member is 12" or less
4. If any suspension location in the run exceeds the above, the entire run must be braced.

4. SCHEDULES

4.1 EQUIPMENT ISOLATOR SCHEDULE

SPECIFICATION SELECTION GUIDE

to be used with
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ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR 4"(100mm)THRU 6"(150mm)THICK SOLID CONCRETE FLOORS (note 7)										
	Ground Supported Slab or Basement		20'(6m) Floor Span Possible Floor Defl.-0.67"(17mm)		30'(9m) Floor Span Possible Floor Defl.-1.0"(25mm)		40'(12m) Floor Span Possible Floor Defl.-1.33"(34mm)		50'(15m) Floor Span Possible Floor Defl.-1.67"(42mm)	
	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)	Isolation & Seismic Spec.	Isolation Deflection in(mm)
REFRIG. MACHINES										
Absorption Machines	2-23	0.35(9)	6-23	0.75(19)	6-23	0.75(19)	6-23	1.5(38)	6-23	1.5(38)
Centrifugal Chillers or Heat Pumps										
Cooler Condenser Mounted Hermetic Compressors	2-23	0.35(9)	6-23	0.75(19)	6-23 or 9*-23	1.5(38)	6-23 or 9*-23	1.5(38)	6-20-23 or 9*-23	2.5(64)
Cooler Condenser Alongside Hermetic Compressors	2-23	0.35(9)	6-23	0.75(19)	6-23 or 9*-23	1.5(38)	6-23 or 9*-23	1.5(38)	6-23 or 9*-23	2.5(64)
Open Type Compressors (note 3)	2-20-23 or 2-20-23	0.35(9)	6-20-23 or 6-20-23	0.75(19)	6-20-23 or 9*-20-23	1.5(38)	6-20-23 or 9*-20-23	1.5(38)	6-20-23 or 9*-20-23	2.5(64)
Refrig. Reciprocating Compressors										
500 rpm to 750 rpm	6-23	0.75(19)	6-23	1.5(38)	6-23	1.5(38)	6-20-23	2.5(64)	6-20-23	3.5(89)
751 rpm and Over	6-23	0.75(19)	6-23	0.75(19)	6-23 or 9*-23	1.5(38)	6-20-23 or 9*-20-23	2.5(64)	6-20-23 or 9*-20-23	3.5(89)
Reciprocating Chillers or Heat Pumps										
500 rpm to 750 rpm	6-23	0.75(19)	6-23	1.5(38)	6-23	1.5(38)	6-20-23	2.5(64)	6-20-23	3.5(89)
751 rpm and Over	6-23	0.75(19)	6-23	0.75(19)	6-20-23	1.5(38)	6-20-23	2.5(64)	6-20-23	3.5(89)
Refrigeration Screw Compressors	9*-23		9*-23		9*-23		9*-23		9*-23	
PACKAGED STEAM GENERATIONS (Boilers)	2-24	0.35(9)	6-24	0.75(19)	6-24	0.75(19)	6-24	1.5(38)	5,23,24	2.5(64)
Pumps										
Close Coupled										
Thru 5hp (4kw)	2-21-23	0.35(9)	5-16- 21-23	0.75(19)	5-16- 21-23	0.75(19)	5-16- 21-23	1.5(38)	5-16- 21-23	1.5(38)
7 1/2hp (5.6kw) and Larger	5-16- 21-23	0.75(19)	5-16- 21-23	0.75(19)	5-16- 21-23	1.5(38)	5-16- 21-23	1.5(38)	5-16- 21-23	2.5(64)
Base Mounted (note 2)										
Thru 60hp (45kw)	5-16- 21-23	0.75(19)	5-16- 21-23	0.75(19)	5-16- 21-23	1.5(38)	5-16- 21-23	1.5(38)	5-16- 21-23	2.5(64)
75hp (56kw) and Larger	5-16- 21-23 or 8*-16 21-23	0.75(19)	5-16- 21-23 or 8*-16 21-23	1.5(38)	5-16- 21-23 or 8*-16 21-23	2.5(64)	5-16- 21-23 or 8*-16 21-23	2.5(64)	5-16- 21-23 or 8*-16 21-23	3.5(89)
PIPE RISERS	5 or 10- 25-26	Spec. 5 if floor supported and Spec. 10 if ceiling suspended. Spec. 25 anchors if required, Spec. 26 guides required on all risers. Deflections are based on the expansion or contraction of each riser.								

*NOTE: Isolators in **Red** are Air Springs recommended for highly critical locations.

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	Ground Supported Slab or Basement		20'(6m) Floor Span Possible Floor Defl.-0.67"(17mm)		30'(9m) Floor Span Possible Floor Defl.-1.0"(25mm)		40'(12m) Floor Span Possible Floor Defl.-1.33"(34mm)		50'(15m) Floor Span Possible Floor Defl.-1.67"(42mm)	
	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)	Isol. & Seismic Spec.	Isol. Defl. in(mm)
FACTORY ASSEMBLED H & V UNITS										
Curb Mounted Roof Top Units	—	—	22	1.0(25)	22	1.5(38)	22	2.5(64)	22	2.5(64)
Suspended Units (for Fan Heads see Blowers Guide)										
Thru 5hp (4kw)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)
7 1/2 hp (5.6kw) and Larger- 275 rpm to 400 rpm	10A-12	1.5(38)	10A-12	1.5(38)	10A-12	1.5(38)	10A-12	1.5(38)	10A-12	1.5(38)
7 1/2 hp (5.6kw) and Larger- 401 rpm and Over	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.0(25)	10A-12	1.5(38)	10A-12	2.5(64)
Floor Mounted Units (for Fan Heads see Blowers Guide)										
Thru 5hp (4kw)	2	0.35(9)	7	0.75(19)	7	0.75(19)	7	0.25(6)	7	0.75(19)
7 1/2 hp (5.6kw) and Larger- 275 rpm to 400 rpm	2	0.35(9)	7	1.5(38)	7	1.5(38)	7	1.5(38)	7	1.5(38)
7 1/2 hp (5.6kw) to 40hp- 401 rpm and Over	2	0.35(9)	7	0.75(19)	7	0.75(19)	7	1.5(38)	5-16-20	2.5(64)
50hp (38kw) and Larger- 401 rpm and Over	2	0.35(9)	7	0.75(19)	7	1.5(38)	5-16-20	2.5(64)	5-16-20	3.5(89)
AIR COMPRESSOR										
Tank Mounted Type	5-16- 21-24	0.75(19)	5-16- 21-24	0.75(19)	5-16- 21-24	1.5(38)	5-16- 21-24	2.5(64)	5-16- 21-24	3.5(89)
V - W Type	5-16- 21-24	0.75(19)	5-16- 21-24	0.75(19)	5-16- 21-24	1.5(38)	5-16- 21-24	2.5(64)	5-16- 21-24	3.5(89)
Horz, Vert, 1 or 2 Cylinders										
275 rpm to 499 rpm	5-16- 21-24	2.5(64)	5-16- 21-24	2.5(64)	5-16- 21-24	2.5(64)	5-16- 21-24	3.5(89)	5-16- 21-24	3.5(89)
500 rpm to 800 rpm	5-16- 21-24	1.5(38)	5-16- 21-24	1.5(38)	5-16- 21-24	2.5(64)	5-16- 21-24	3.5(89)	5-16- 21-24	3.5(89)
Specification should read "21" type inertia bases with sufficient mass to limit motion to a theoretical double amplitude of 0.03"(.7mm)										

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SPECIFICATION SELECTION GUIDE			ISOLATION, DEFLECTION AND SEISMIC RESTRAINT CRITERIA FOR 4"(100mm)THRU 6"(150mm)THICK SOLID CONCRETE FLOORS (note 7)									
			Ground Supported Slab or Basement		20'(6m) Floor Span Possible Floor Defl. 0.67"(17mm)		30'(9m) Floor Span Possible Floor Defl. 1.0"(25mm)		40'(12m) Floor Span Possible Floor Defl. 1.33"(34mm)		50'(15m) Floor Span Possible Floor Defl. 1.67"(42mm)	
			Isolation & Seismic Spec.	Isolation Deflection in(mm)	Engineering Specifications and Minimum Static Deflection as tabulated below (note 1)							
to be used with Vibration Control Engineering Specifications for HVAC Equipment in Office Buildings, Colleges, Theatres and Similar Structures												
BLOWERS												
Utility Sets												
Floor Mounted (note 5)			2	0.35(9)	Spec 7 for 0.75" (19mm) and 1.5" (38mm) deflection and Spec 5-20-16 for over 1.5" (38mm) deflection with deflection from Blower Minimum Deflection Guide, but not to exceed 2.5" (64mm)							
Roof Mounted			—	—	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide. If roof will not handle concrete base load use Spec 6 for 0.75" (19mm) and 1.5" (38mm) deflection and Spec 6-20 for over 1.5" (38mm) deflection.							
Suspended Unit (note 5)			—	—	Spec 10A-12 with deflection from Blower Minimum Deflection Guide, not to exceed 2.5" (64mm) deflection.							
Centrifugal Blowers (note 6)			2-21	0.35(9)	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide.							
Fan Heads												
Floor Mounted			2-28	0.35(9)	Spec 7-28 if 0.75" (19mm) or 1.5" (38mm) deflection or Spec 5-20-16-28 for deflection over 1.5" (38mm) to 4.5" (114mm) from Blower Minimum Deflection Guide.							
Suspended Units			Spec 10A-12-28 with deflection from Blower Minimum Deflection Guide.									
Tubular Centrifugal and Axial Fans												
Suspended Units			Spec 10A-12 with deflection from Blower Minimum Deflection Guide, Spec 10A-12-28 for over 4" (100) static pressure.									
Floor Mounted with Motor on/in Fan Casing			2	0.35(9)	Spec 7 for 0.75" (19mm) to 1.5" (38mm) deflection and Spec 5-20-16 for over 1.5" (38mm) deflection with deflection from Blower Minimum Deflection Guide, Spec 5-21-16 or 5-16-28 for over 4" (100mm) static pressure.							
Floor Mounted Arrangement 1 or any Separately Mounted Motor			2-21	0.35(9)	Spec 5-21-16 with deflection from Blower Minimum Deflection Guide.							
COOLING TOWERS & CONDENSING UNITS			2	0.35(9)	Spec 6 or 9* with deflection from Blower Minimum Deflection Guide.							
ELECTRICAL EQUIPMENT												
Transformers												
Wall Mounted			3-18	—	3-18	—	3-18	—	3-18	—	3-18	—
Floor Mounted			2-19	0.2(5)	6-19 or 9*-19	0.75(19)	6-19 or 9*-19	1.50(38)	6-19 or 9*-19	2.5(64)	6-19 or 9*-19	3.5(89)
Switchgear & Substations			4-19		4-19		4-19		4-19		4-19	
Generators												
500 rpm to 750 rpm			5-17- 21-23	0.75(19)	5-17- 21-23	1.50(38)	5-17- 21-23	1.50(38)	5-17- 21-23	2.5(64)	5-17- 21-23	3.5(89)
751 rpm and over			5-17- 21-23	0.75(19)	5-17- 21-23	0.75(19)	5-17- 21-23	1.50(38)	5-17- 21-23	2.5(64)	5-17- 21-23	3.5(89)
Panelboards			3-18	—	3-18	—	3-18	—	3-18	—	3-18	—
Motor Starters												
Wall Mounted			3-18	—	3-18	—	3-18	—	3-18	—	3-18	—
Floor Mounted			4-19	—	4-19	—	4-19	—	4-19	—	4-19	—
Cable Trays, Bus Ducts & Conduit			12 or 13	—	12 or 13	—	12 or 13	—	12 or 13	—	12 or 13	—

Blower Minimum Deflection Guide

When blowers are 60 HP (45kw) or larger, select deflection requirements for next larger span. A minimum of 2.5" (64mm) should be used unless larger deflections are called for on the chart or these fans are located in the lowest sub-basement or on a slab on grade.

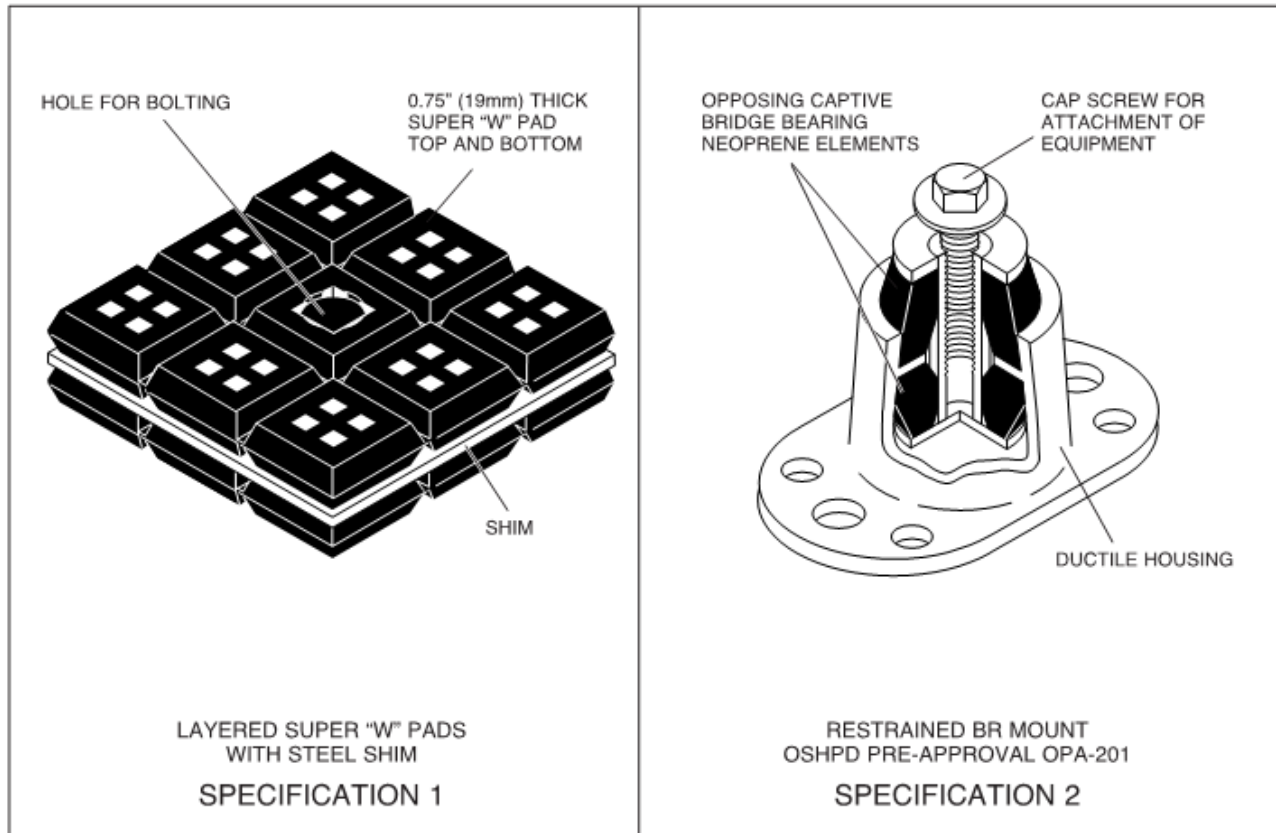
Fan Speed RPM	Required Deflection for Ground Supported Slab or Basement	Required Deflection for 20' (6m) Floor Span	Required Deflection for 30' (9m) Floor Span	Required Deflection for 40' (12m) Floor Span	Required Deflection for 50' (15m) Floor Span
500 and up	0.35" (9mm)	0.75" (19mm)	1.5" (38mm)	2.5" (64mm)	3.5" (89mm)
375-499	0.35" (9mm)	1.5" (38mm)	2.5" (64mm)	3.5" (89mm)	3.5" (89mm)
300-374	0.35" (9mm)	2.5" (64mm)	2.5" (64mm)	3.5" (89mm)	3.5" (89mm)
225-299	0.35" (9mm)	3.5" (89mm)	3.5" (89mm)	3.5" (89mm)	3.5" (89mm)
175-224	0.35" (9mm)	3.5" (89mm)	4.5" (114mm)	4.5" (114mm)	4.5" (114mm)

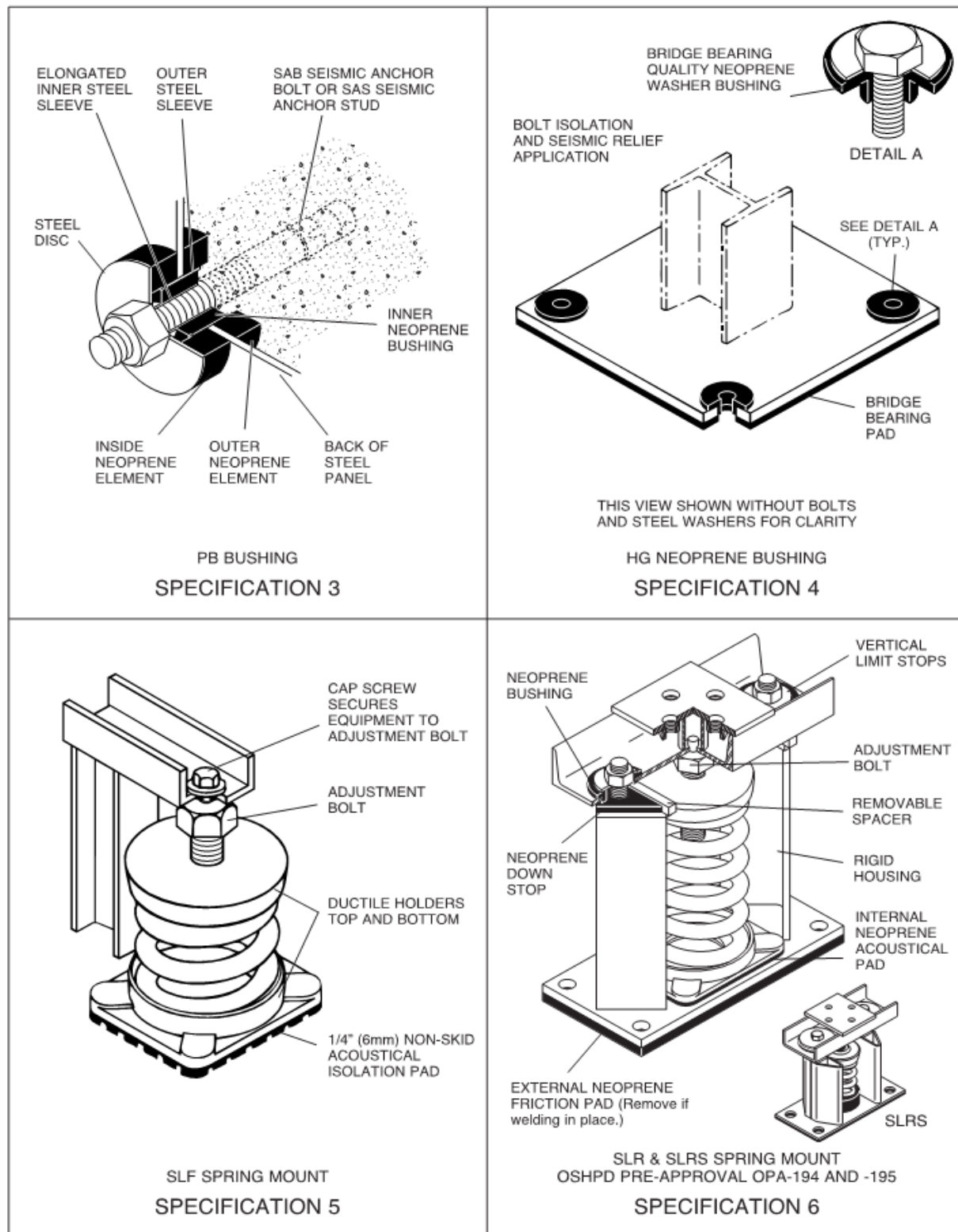
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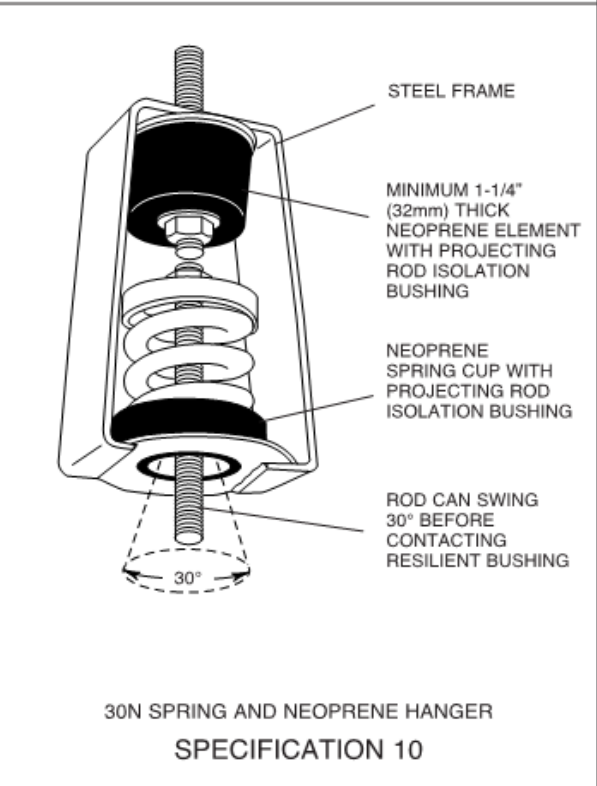
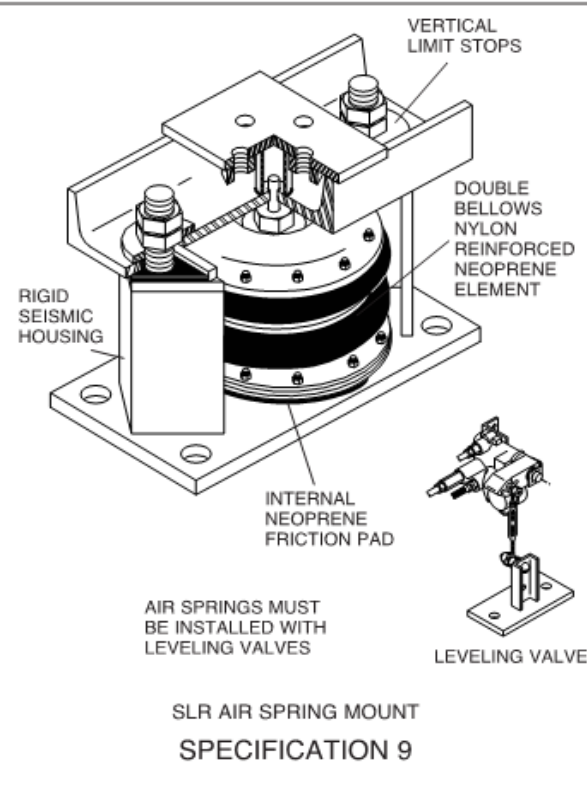
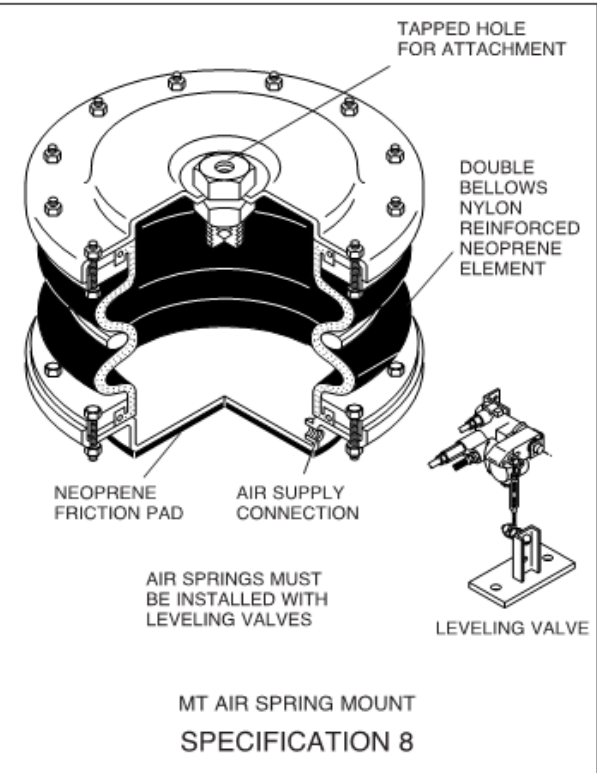
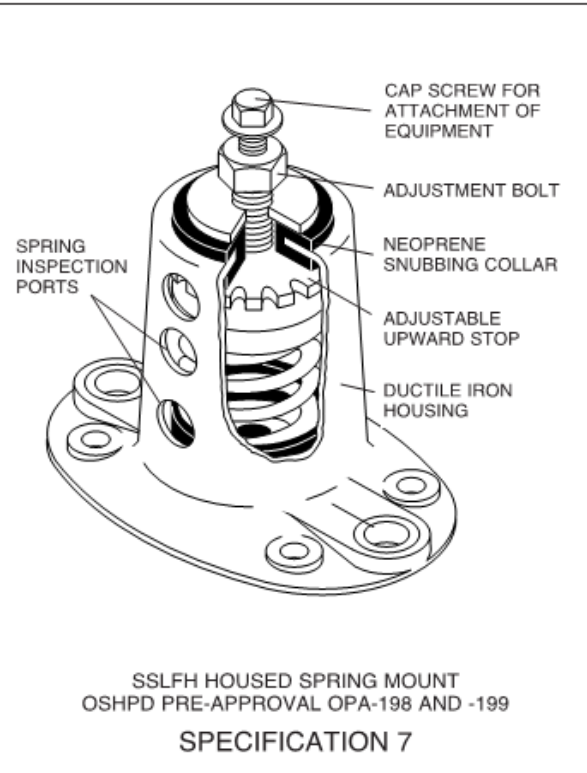
- Minimum deflection called for in this specification are not 'nominal' but certifiable minimums. The 0.75"(19mm), 1.5"(38mm), 2.5"(64mm), 3.5"(89mm), and 4.5"(114mm) minimums should be selected from manufacturers nominal 1"(25mm), 2"(50mm), 3"(75mm), 4"(100mm) and 5"(125mm) series respectively. Air spring isolation specifications 8 & 9 may be substituted for steel springs above in highly sensitive noise free locations.
- Vacuum, Condensate or Boiler Feed Pumps shall be mounted with their tanks on a common spec. 21 base with deflections as specified for base mounted pumps.
- The base described in spec. 20 is used under the drive side. Individual mountings as described in spec. 6 are used under the Cooler and Condenser.
- This type of compressor is highly unbalanced and sometimes requires inertia bases weighing 5 to 7 times equipment weight to reduce running motion.
- Limit deflection for utility sets 18" (450mm) wheel diameter and smaller to 1 1/2" (38mm).
- FLOATING CONCRETE INERTIA BASES. Floating concrete inertia bases do not reduce vibration transmitted to the structure through the mountings. These bases will reduce vibratory motion, provide a very rigid machine base and minimize spring reactions to fan thrust. Engineers preferring steel bases rather than the concrete mentioned above in specification 5-21 should change the designation to 5-20. Concrete is preferred for all fans operating at static pressure above 4" (100mm) and on roof tops.
- LIGHT FLOOR CONSTRUCTION. When floors or roofs are lighter than 4" (100mm) solid concrete it is desirable to introduce a localized mass under the vibration mountings in the form of a sub-base. This sub-base should be 12" (300mm) thick and 12" (300mm) longer and wider than the mechanical equipment above it. When this mass is provided the 30' (9m) minimum static deflection requirements will suffice even in longer bays. The mass is also useful for unusually large bays over 50' (15m). When floors are lighter than the 4" (100mm) concrete or the location is in a particularly sensitive area and the mass described above cannot be introduced, select deflection requirements for the next larger span.

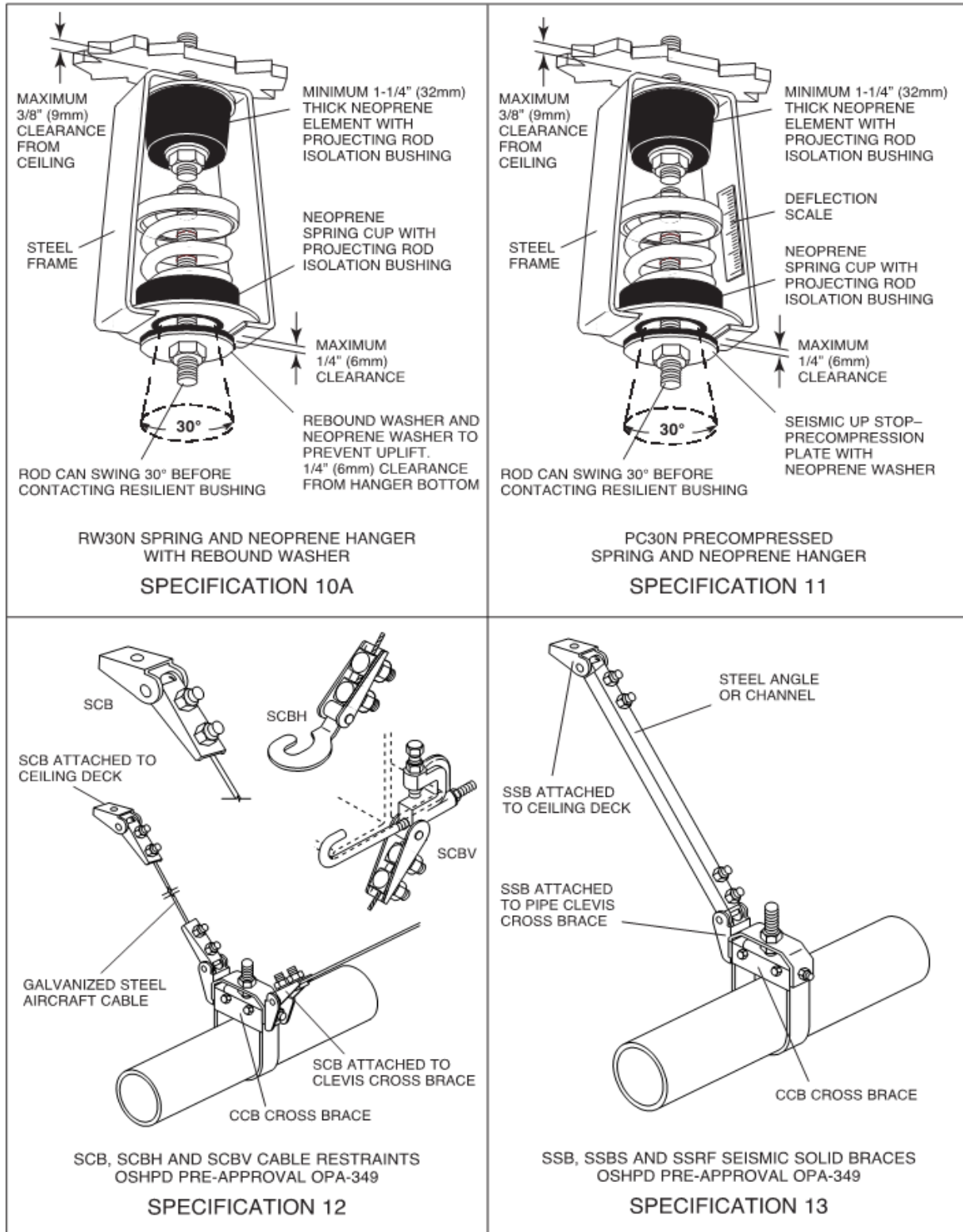
8. For equipment where increased resiliency and decreased accelerations are required, change specification 16 snubbers to specification 17 snubbers.

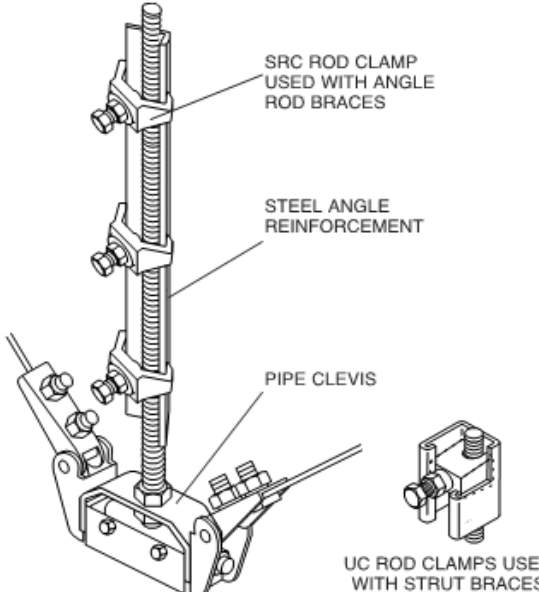
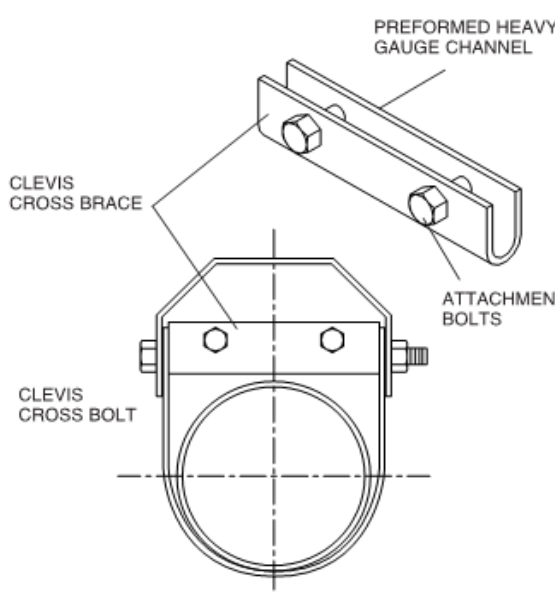
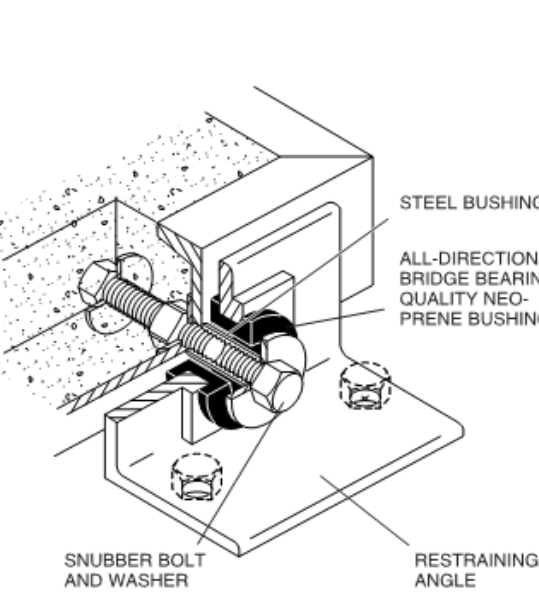
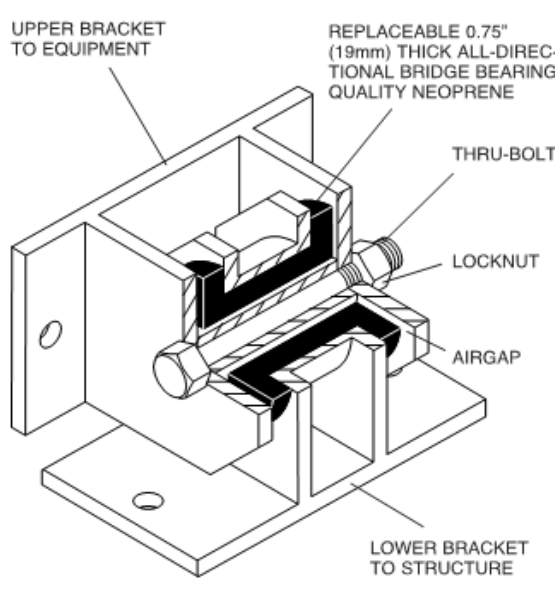
SPECIFICATION PRODUCT DETAILS

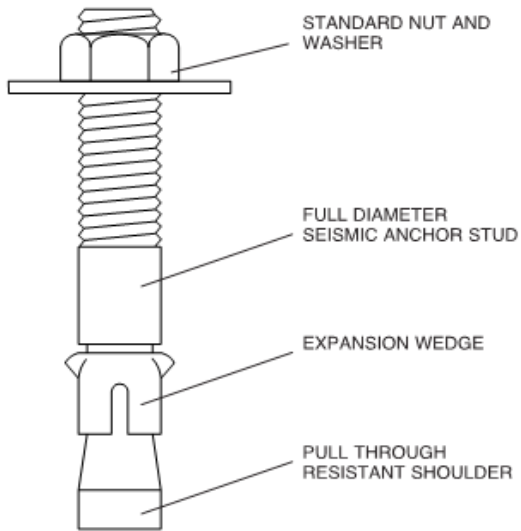




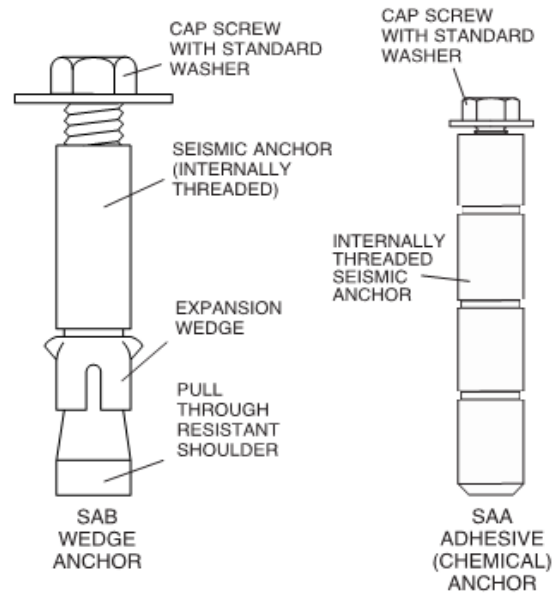




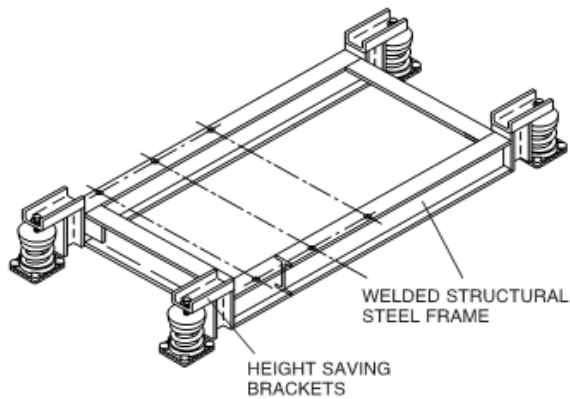
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 Z-1225 ALL-DIRECTIONAL SEISMIC SNUBBER OSHDP PRE-APPROVAL OPA-196 SPECIFICATION 16	 Z-1011 ALL-DIRECTIONAL SEISMIC SNUBBER OSHDP PRE-APPROVAL OPA-197 SPECIFICATION 17



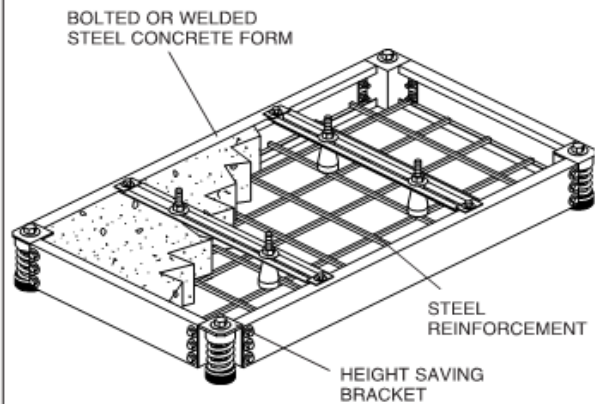
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ICBO APPROVAL REPORT No. 1821
SPECIFICATION 18



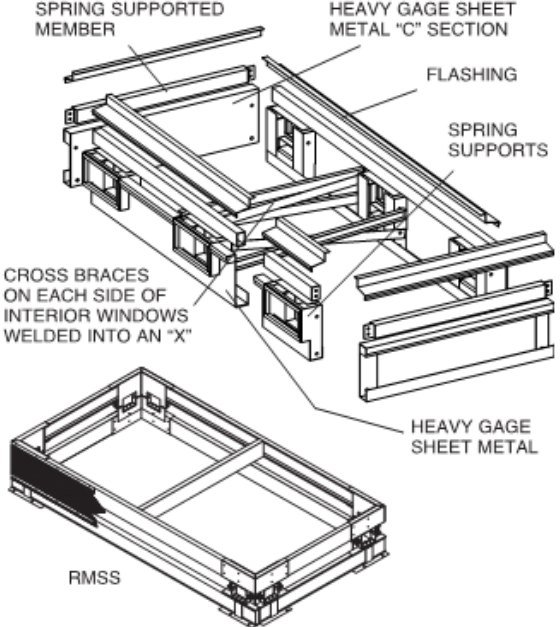
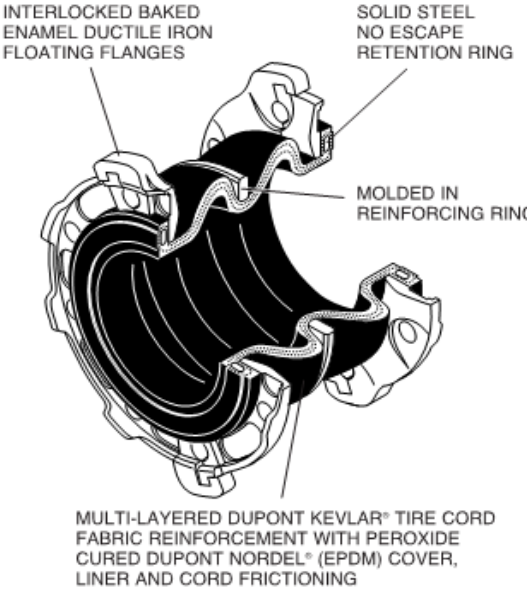
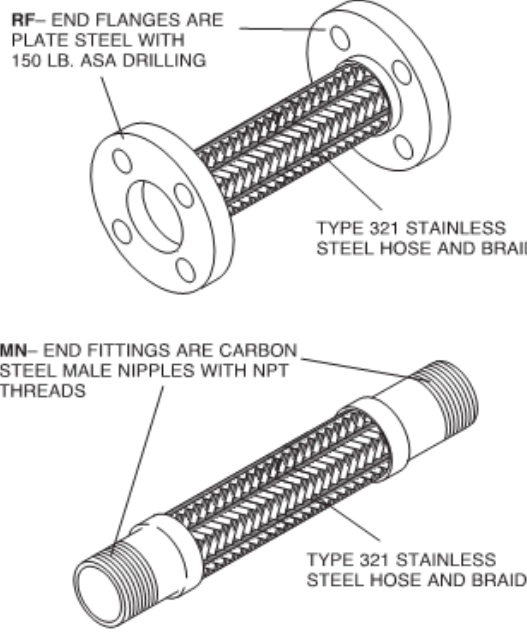
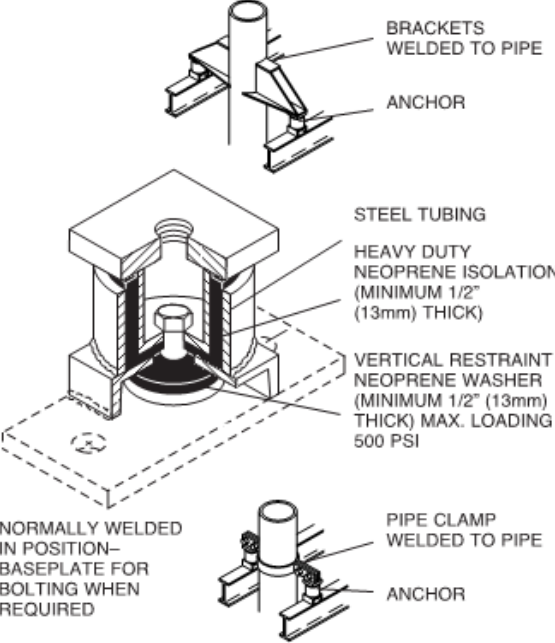
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SPECIFICATION 19

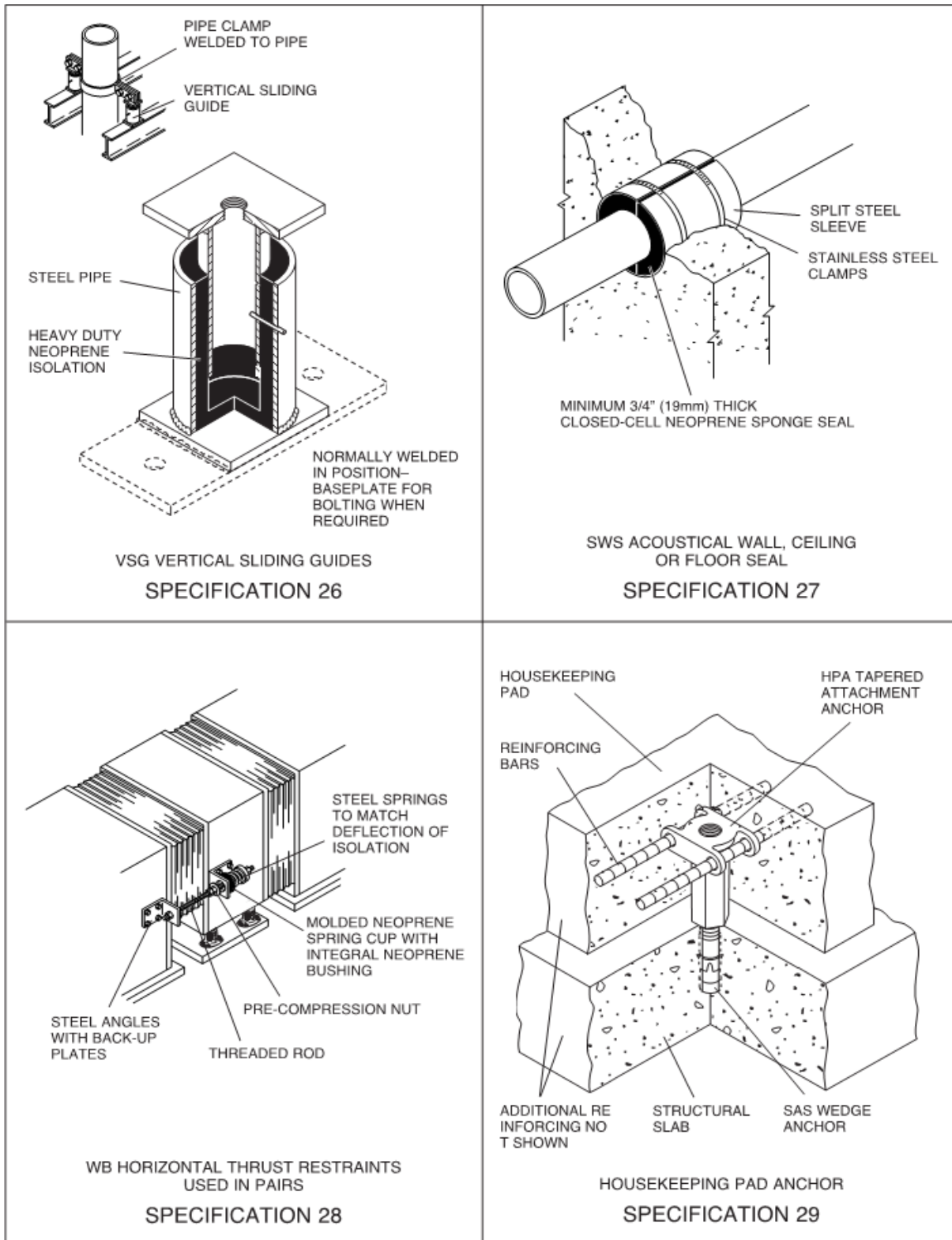


WF WIDE FLANGE STEEL BASE
SPECIFICATION 20



BMK CONCRETE FORM BASE
SPECIFICATION 21

 SRSC & RMSS SEISMIC ROOFTOP CURB OSHPD PRE-APPROVAL OPA-207 SPECIFICATION 22	 SFDEJ MOLDED EXPANSION JOINT SPECIFICATION 23
 BSSRF and BSSMN STAINLESS STEEL HOSE SPECIFICATION 24	 ADA ALL-DIRECTIONAL ANCHOR SPECIFICATION 25



END OF SECTION 23 05 48

SECTION 23 05 53 - HVAC IDENTIFICATION

1. GENERAL

1.1 SECTION INCLUDES

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

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References.
- C. Submittals.
 - 1. Product Data: For each type of product indicated.
 - 2. Equipment-Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
 - 3. Valve-numbering scheme.
 - 4. Valve Schedules: For each piping system. Include in operation and maintenance manuals.
- D. Operation and maintenance manuals.
- E. Project record documents
 - 1. Record actual locations of tagged valves.
- F. Delivery, storage, and handling.

2. PRODUCTS

2.1 NAMEPLATES

- A. Equipment Mark Nameplates: Laminated three-layer plastic with engraved black letters (matching equipment mark indicated on drawings) on light contrasting background color, with minimum 3/4 inch high letters.
- B. Equipment Nameplates: Factory-applied permanent nameplate indicating the manufacturer's name, model, serial number, temperature and pressure design, and any other data necessary to conform with specified requirements. On equipment installed outdoors, nameplate shall be stamped steel or engrave plastic.

2.2 TAGS

- A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.
- B. Chart: Typewritten list that is plastic laminated and mounted in mechanical room. Valve list is to coordinate with mechanical piping schematics if provided on plans.
- C. Pipe Schematics: Valve numbers are to be labeled on Engineer schematic drawings, plastic laminated and schematic shall be mounted in mechanical room.

2.3 PIPE MARKERS

- A. Color: Conform to ASME A13.1, latest revision
- B. Plastic Tape Pipe Markers: Minimum 1-1/2" letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings; minimum information indicating flow direction arrow and identification of fluid being conveyed. VOC Limit: 50 g/L.
- C. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4-mil thick, manufactured for direct burial service. Provide tape with printing which most accurately indicates the type of service of buried pipe.

2.4 DUCT MARKERS

- A. Plastic Tape Duct Markers: Minimum 1-1/2" letter size and 2-mil thickness, flexible, vinyl film tape with pressure sensitive adhesive backing and printed marking; minimum information indicating flow direction arrow and identification of air system being conveyed.

3. EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic tape pipe and duct markers in accordance with manufacturer's instructions. Directional arrow tape shall be overlapped to ensure proper adhesion and no peeling of tape in future.
- D. Identify air handling units, exhaust fans, chillers, pumps, heat generating, heat rejecting, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

- E. Identify control panels and major control components outside panels with plastic nameplates.
- F. Tag automatic controls, instruments, and relays. Key to control schematic.
- G. Identify piping, concealed or exposed, with plastic tape pipe markers. Identify service, flow direction, and pressure when applicable, i.e. low pressure steam, high pressure steam. Install in clear view from floor and align with axis of piping. Locations of identification not to exceed 15 feet on straight runs including risers and drops, more often in congested areas, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction. Provide a minimum one label per pipe per room. Where pipes are racked, install pipe markers on each pipe in the same location to aid in differentiating each pipe in the rack.
- H. Identify ductwork with plastic tape duct markers. Identify service, flow direction and pressure when applicable, i.e. low pressure supply air, high pressure supply air. Install in clear view from floor and align with centerline of duct. Locations of identification not to exceed 15 feet from straight runs including risers and drops, more often in congested areas, at each side of penetration of structure or wall, and at each obstruction. When several ducts from different units are located in concealed congested areas, locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

END OF SECTION

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

1. GENERAL

1.1 SECTION INCLUDES

- A. Testing, adjustment, and balancing (TAB) of air systems.
- B. Measurement of final operating condition of mechanical systems.

1.2 DEFINITIONS

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

1.3 PREINSTALLATION MEETINGS

- A. TAB Conference: Conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan, to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

- a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.
- B. No balance reports shall be accepted nor final payment made unless such conference occurs and is fully documented as to those attending and subjects covered.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 90 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within **90** days of Contractor's Notice to Proceed, submit the Contract Documents review report, as specified in Part 3.
- C. Strategies and Procedures Plan: Within **90** days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures, as specified in "Preparation" Article.

- D. System Readiness Checklists: Within **90** days of Contractor's Notice to Proceed, submit system readiness checklists, as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications, Certified by AABC:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 - 2. TAB Technician: Employee of the TAB specialist and certified by AABC.
- B. TAB Specialists Qualifications, Certified by NEBB or TABB:
 - 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."
- E. Code and AHJ Compliance: TAB is required to comply with governing codes and requirements of authorities having jurisdiction.

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. References.
- B. Submittals.
- C. Project record documents
- D. Quality assurance.

1.7 PROJECT CONDITIONS

1. Sequence work to commence after completion of systems and schedule completion of work before Substantial Completion of Project.

1.8 SCHEDULING/COORDINATION.

1. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.
2. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 EXAMINATION

- A. Before commencing work and prior to convening the pre-balancing conference, the TAB agency shall coordinate with the appropriate mechanical contractors that the following conditions have been met:
 1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
- B. Submit field reports at the pre-balancing conference. Report ALL defects and deficiencies noted during performance of services which prevent system balance.
- C. Beginning of work means acceptance of existing conditions.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following
 1. Permanent electrical-power wiring is complete.
 2. Automatic temperature-control systems are operational.
 3. Equipment and duct access doors are securely closed.
 4. Balance, smoke, and fire dampers are open.
 5. Isolating and balancing valves are open and control valves are operational.
 6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided. Windows and doors can be closed so indicated conditions for system operations can be met.

- C. Windows and doors can be closed so indicated conditions for system operations can be met.
- D. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.
- E. Provide additional balancing devices as required.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within +5 to 10 percent of design for supply systems, return and exhaust systems.
- B. Air Outlets in Negatively Pressurized Spaces: Adjust total to within 0 to -5 percent of design to space.
- C. Air Inlets in Negatively Pressurized Spaces: Adjust total to within 0 to +5 percent of design from space.
- D. Air Outlets in Positively Pressurized Spaces: Adjust total to within 0 to +5 percent of design to space.
- E. Air Inlets in Positively Pressurized Spaces: Adjust total to within 0 to -5 percent of design from space.
- F. Air Outlets in Non-Pressurized Spaces: Adjust total to within 0 to +10 percent of design to space.
- G. Air Inlets in Non-Pressurized Spaces: Adjust total to within 0 to -10 percent of design from space.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 - Ductwork Accessories.
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 - Ductwork Insulation.
- B. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings
- C. Ensure recorded data represents actual measured or observed conditions.
- D. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Section 23 31 13 – Ductwork.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.

- a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - c. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
5. First two subparagraphs below may require changes to installed systems or equipment; these changes may require a contract modification.
6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
 - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - 3. Measure total system airflow. Adjust to within indicated airflow.
 - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
 - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
 - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
 - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.

7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

3.8 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
1. Manufacturer's name, model number, and serial number.
 2. Motor horsepower rating.
 3. Motor rpm.
 4. Efficiency rating.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.9 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each electric heating coil:
1. Nameplate data.
 2. Airflow.
 3. Entering- and leaving-air temperature at full load.
 4. Voltage and amperage input of each phase at full load and at each incremental stage.
 5. Calculated kilowatt at full load.
 6. Fuse or circuit-breaker rating for overload protection.
- B. Measure, adjust, and record the following data for each refrigerant coil:
1. Dry-bulb temperature of entering and leaving air.
 2. Wet-bulb temperature of entering and leaving air.
 3. Airflow.
 4. Air pressure drop.
 5. Refrigerant suction pressure and temperature.

3.11 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Fan curves.
 - 2. Manufacturers' test data.
 - 3. Field test reports prepared by system and equipment installers.
 - 4. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - 12. Indicated versus final performance.
 - 13. Notable characteristics of systems.
 - 14. Description of system operation sequence if it varies from the Contract Documents.
 - 15. Nomenclature sheets for each item of equipment.
 - 16. Data for terminal units, including manufacturer's name, type, size, and fittings.
 - 17. Notes to explain why certain final data in the body of reports vary from indicated values.
 - 18. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor, return, and exhaust air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
 - 1. Quantities of outdoor, supply, return, and exhaust airflows.
 - 2. Duct, outlet, and inlet sizes.

3. Terminal units.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Unit arrangement and class.
- g. Discharge arrangement.
- h. Sheave make, size in inches (mm), and bore.
- i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- j. Number, make, and size of belts.
- k. Number, type, and size of filters.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm (L/s).
- b. Total system static pressure in inches wg (Pa).
- c. Fan rpm.
- d. Discharge static pressure in inches wg (Pa).
- e. Filter static-pressure differential in inches wg (Pa).
- f. Preheat-coil static-pressure differential in inches wg (Pa).
- g. Cooling-coil static-pressure differential in inches wg (Pa).
- h. Heating-coil static-pressure differential in inches wg (Pa).
- i. Outdoor airflow in cfm (L/s).
- j. Return airflow in cfm (L/s).
- k. Outdoor-air damper position.
- l. Return-air damper position.

F. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Coil identification.
- d. Capacity in Btu/h (kW).
- e. Number of stages.
- f. Connected volts, phase, and hertz.

- g. Rated amperage.
- h. Air flow rate in cfm (L/s).
- i. Face area in sq. ft. (sq. m).
- j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):

- a. Heat output in Btu/h (kW).
- b. Air flow rate in cfm (L/s).
- c. Air velocity in fpm (m/s).
- d. Entering-air temperature in deg F (deg C).
- e. Leaving-air temperature in deg F (deg C).
- f. Voltage at each connection.
- g. Amperage for each phase.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches (mm), and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm (L/s).
- b. Total system static pressure in inches wg (Pa).
- c. Fan rpm.
- d. Discharge static pressure in inches wg (Pa).
- e. Suction static pressure in inches wg (Pa).

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System and air-handling-unit number.

- b. Location and zone.
- c. Traverse air temperature in deg F (deg C).
- d. Duct static pressure in inches wg (Pa).
- e. Duct size in inches (mm).
- f. Duct area in sq. ft. (sq. m).
- g. Indicated air flow rate in cfm (L/s).
- h. Indicated velocity in fpm (m/s).
- i. Actual air flow rate in cfm (L/s).
- j. Actual average velocity in fpm (m/s).
- k. Barometric pressure in psig (Pa).

I. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Air velocity in fpm (m/s).
- c. Preliminary air flow rate as needed in cfm (L/s).
- d. Preliminary velocity as needed in fpm (m/s).
- e. Final air flow rate in cfm (L/s).
- f. Final velocity in fpm (m/s).
- g. Space temperature in deg F (deg C).

J. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.12 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Balancer shall be available for walk-thru with equipment required for verification.

3. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - c. Verify that balancing devices are marked with final balance position.
 - d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by the owner
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of the owner
3. Owner shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS

- B. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- C. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 13 - DUCTWORK INSULATION

1. GENERAL

1.1 SECTION INCLUDES

- A. Ductwork insulation.
- B. Duct liner.
- C. Insulation jackets.
- D. Related Requirements:
 - 1. Section 23 07 19 "HVAC Piping Insulation."
 - 2. Section 23 31 13 "Ductwork".

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "HVAC Hangers and Supports."

- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

1.8 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

- 1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.9 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. References.
- B. Submittals.
- C. Delivery, Storage, and Handling.
- D. Quality assurance.
- E. Qualifications.
- F. Environmental requirements.
- 1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
 - 2. Maintain temperature during and after installation as recommended by the manufacturer.

2. PRODUCTS

2.1 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. 'K' value: ASTM C518, 0.30 at 75 degrees F.
 - 2. Maximum service temperature: 250 degrees F.
 - 3. ASTM C1104 Water Vapor Sorption less than 5% by weight
 - 4. Density: 1.5 lb/cu ft.

B. Vapor Barrier Jacket

1. Vapor Retarder Jacket: FSK or PSK confirming to ASTM C 1136 Type I, II.
2. Moisture vapor transmission: ASTM E96; 0.02 perm maximum.
3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape

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

D. Tie Wire: Annealed steel, 16 gage (1.5 mm).

2.2 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible blanket.

1. 'K' value: ASTM C518, 0.23 at 75 degrees F.
2. Maximum service temperature: 250 degrees F.
3. Maximum moisture absorption: less than 3 percent by volume.
4. Density (concealed locations): 3.0 lb/cu ft.
5. Density (exposed locations): 6.0 lb/cu ft.

B. Vapor Barrier Jacket

1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Secure with pressure sensitive tape.

C. Vapor Barrier Tape

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

2.3 CELLULAR FOAM

A. Insulation: ASTM C534; flexible, cellular elastomeric, sheet.

1. 'K' ('ksi') Value: ASTM C177 or C518; 0.27 at 75 degrees F.
2. Minimum Service Temperature: -40 degrees F.
3. Maximum Service Temperature: 220 degrees F.
4. Maximum Moisture Absorption: ASTM D209; 0.2 percent by volume.
5. Moisture Vapor Transmission: ASTM E96; 0.08 perm-inches.
6. Maximum Flame Spread: ASTM E84; 25.
7. Maximum Smoke Developed: ASTM E84; 50.
8. Connection: Waterproof vapor barrier adhesive.

B. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.4 DUCT LINER

A. Liner Material:

1. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - a. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - b. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
 - 1) For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - a. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - b. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - 1) For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Natural-Fiber Duct Liner: 85 percent cotton, 10 percent borate, and 5 percent polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.
 - a. Maximum Thermal Conductivity: 0.24 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature when tested according to ASTM C 518.
 - b. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to ASTM E 84; certified by an NRTL.
 - c. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - 1) For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick material matching ductwork material (galvanized steel, aluminum, stainless steel); with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Securing method in first subparagraph below is for ducts with air velocities of 2500 fpm (12.7 m/s) and lower. Use caution when designing lined ducts with air velocities higher than 2500 fpm (12.7 m/s). See SMACNA for requirements.
8. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
9. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

3. EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- C. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
- D. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- E. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.

- F. Secure insulation without vapor barrier with staples (staples only work well when there is a facing present), tape, or wires.
- G. 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.
- H. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
- I. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- J. Do not overtighten and/or compress flexible glass fiber duct insulation.
- K. At duct access doors or other openings, insulation shall be properly framed and finished.
- L. Duct Liner Application:
 - 1. Install in accordance with SMACNA HVAC Duct Construction Standard and all manufacturer recommendations.
 - 2. Adhere insulation with adhesive for 100 percent coverage.
 - 3. Secure insulation with mechanical liner fasteners if recommended by manufacturer. Refer to SMACNA Standards for spacing.
 - 4. Seal and smooth joints.
 - 5. Seal liner surface penetrations, tears or raw edges with adhesive.
 - 6. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.3 GLASS FIBER DUCTWORK INSULATION SCHEDULE

Ductwork Application:	Type:	Min Thickness:	Vapor Barrier Required (Y/N):
Exposed rectangular supply air duct in mechanical rooms and chases	Rigid	2"	Y
Exposed round supply air duct in mechanical rooms	Flexible	2"	Y
Exposed rectangular and round return air duct in mechanical rooms	None required unless shown on plans		
Exposed rectangular and round return air duct or exhaust air duct in other areas	None required unless shown on plans		
Exposed rectangular and round supply air duct upstream of terminal units	Flexible	2"	Y
Exposed rectangular supply air duct downstream of terminal units	Rigid	1-1/2"	Y
Exposed round supply air duct downstream of terminal units	Double-wall ductwork		
Concealed rectangular and round supply air duct upstream of terminal units	Flexible	2"	Y
Concealed rectangular supply air duct downstream of terminal units	Liner	1-1/2"	Y
Concealed round supply air duct downstream of terminal units	Flexible	2"	Y
Concealed return air duct	Liner	1"	Y
Concealed exhaust air duct	None required unless shown on plans		
Return air grille boots/transfer ducts (where indicated on drawings)	Liner	1"	N

Schedule Notes:

- A. All ductwork in mechanical rooms shall be insulated as though it were "Exposed".
- B. Any exterior ductwork requiring insulation from the categories above shall be insulated as "Exterior."

END OF SECTION

SECTION 23 07 19 – HVAC PIPING INSULATION

1. GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Related Requirements:
 - 1. Section 23 07 13 "Duct Insulation" for duct insulation.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of manufacturer, fabricator, type, description, and size.

1.6 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 23 05 29 "HVAC Hangers and Supports."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.**

1.7 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84 by a testing agency acceptable to authority having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.8 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. Quality assurance.
- B. References.
- C. Submittals.
- D. Operation and maintenance manuals.
- E. Project record documents.
- F. Environmental requirements
 - 1. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
 - 2. Maintain temperature during and after installation for minimum period of 24 hours.

2. PRODUCTS

2.1 CELLULAR FOAM

- A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 - 1. 'k' ((btu*in)/(hr*ft²*deg F)) value: ASTM C177 or C518; 0.21 to 0.27 at 75 degrees F mean temperature rating.
 - 2. Minimum Service Temperature: -20 degrees F.
 - 3. Maximum Service Temperature: 180 degrees F.
 - 4. Maximum Moisture Absorption: ASTM C209; 0.2 percent by volume.
 - 5. Moisture Vapor Transmission: ASTM E96; 0.08 perm inches.
 - 6. Maximum Flame Spread: ASTM E84; 25.
 - 7. Maximum Smoke Developed: ASTM E84; 50.

8. Connection: Waterproof vapor barrier adhesive.
 9. Provide documentation indicating that product contains no urea formaldehyde.
 10. Fittings: Pre-fabricated closed cell fittings of like material and thickness as adjacent pipe insulation.
 11. In all exposed finished areas without jacketing, provide white insulation, otherwise use black.
- B. Elastomeric Foam Adhesive: MIL-A-24179A, Type II, Class I, compliant. Air dried, contact adhesive, compatible with insulation. VOC Limit: 50 g/L or less when calculated according to 40 CFR 59, Subpart D.

2.2 JACKETS

A. PVC Plastic

1. Jacket: ASTM C921, One piece molded type fitting covers and sheet material, white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Transmission: ASTM E96; 0.002 perm inches.
 - d. Maximum Flame Spread: ASTM E84; 25.
 - e. Maximum Smoke Developed: ASTM E84; 50.
 - f. Thickness: 20 mil.
 - g. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.
2. Covering Adhesive Mastic: Compatible with insulation and PVC jacket. VOC Limit 50 g/L according to 40 CFR 59, Subpart D (EPA Method 24).

3. EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions.
- B. Painting of cellular foam insulation is not allowed.**
- C. On exposed piping, locate insulation and cover seams in least visible locations. For cellular foam insulation tape ALL visible seams with tape matching insulation color.
- D. Cellular foam insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature:

1. Insulate fittings, joints, flanges, unions, strainers, flexible connectors, and valves with molded insulation of like material and thickness as adjacent pipe. PVC covers are required in all exposed locations as in mechanical rooms.
2. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations.
3. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Inserts and Shields:

1. Refer to Section 23 05 29 for additional information.
2. Application: Piping 1 inch diameter or larger.
3. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
4. Insert Location: Between support shield and piping and under the finish jacket.
5. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
6. Insert Material: ASTM C640 cork, hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
7. Provide inserts and/or shields per manufacturer recommendations for cellular foam insulation applications in order to maintain continuous insulation throughout the pipe system. The removal of sections of cellular foam insulation to accommodate pipe supports is not acceptable. Manufacturer products specifically designed for supporting insulation and maintaining the integrity of the insulation system at pipe hanger locations, such as Armaflex Armafix Insulation Pipe Hangers, are acceptable.

F. Finish insulation at supports, protrusions, and interruptions.

G. For pipe exposed below 10 feet above finished floor, finish with PVC jacket and PVC fitting covers.

H. All valves in insulated systems shall have valve stem extensions. Insulation installer shall notify the contractor and Owner if valves without stem extensions are encountered. All valves without stem extensions in areas where stem extensions are required shall be replaced.

I. **Provide insulation clearance and access to valves and fittings in hangers and from structure and other equipment. Insulation shall be continuous through all hangers and supports. Refer to Section 23 07 19.**

3.3 CELLULAR FOAM INSULATION SCHEDULE

A. Cooling Systems

<u>PIPING SYSTEM:</u>	<u>PIPE SIZE:</u>	<u>MIN. THICKNESS:</u>
Cold Condensate Drains (below ambient)	All sizes	1"
Refrigerant Suction Line	All sizes	1-1/2"
Refrigerant Liquid Line (in spaces 120 degrees and greater)	All sizes	1-1/2"

END OF SECTION

SECTION 23 09 00 - DIGITAL CONTROL EQUIPMENT

1. GENERAL

1.1 SUMMARY

- A. This Section includes control equipment for building mechanical, electrical, plumbing, and fire suppression systems and components.
 - 1. All work of this Division associated with the installation, setup, programming and commissioning of hardware associated with the Building Automation Control system shall be coordinated and provided by the selected and approved Building Automation & Control System (BAS) Contractor.
 - 2. All work of this Division associated with the integration of the Building Level Control system into the existing Siemens Building Automation System Front shall be coordinated and provided by the current Campus System Integrator (CSI) (Powers of Arkansas – Contact: Ron McCarty, 501-350-5728).
 - 3. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference the Division 21, 22, 23, 26, and 28 Sections for details.
 - 4. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.
 - 5. If the BAS Contractor or the CSI Contractor believes there are conflicts or missing information in the project documents, the Contractors shall promptly request clarification and instruction from the design team during the bidding period.

1.2 DEFINITIONS

- A. Analog: A continuously variable system or value not having discrete levels. Typically exists within a defined range of limiting values.
- B. Binary: A two-state system where an “ON” condition is represented by one discrete signal level and an “OFF” condition is represented by a second discrete signal level.
- C. Building Automation & Control System (BAS): The total integrated system of fully operational and functional elements, including equipment, software, programming, and associated materials, to be provided by this Division BAS Contractor and to be interfaced to the associated work of other related trades.
- D. BAS Contractor: The single Contractor to provide the work of this Division. This Contractor shall be the primary manufacturer, installer, setup, programming and commissioning for the building level Control system.
- E. CSI Contractor: Is the current Campus System Integrator (Powers of Arkansas) to provide the work of this Division. This Contractor shall be the responsible for integration of the completed functional building level automation system into the existing Siemens Building automation system front-end. The CSI contractor will be responsible for generation of graphics, setting up scheduling, alarms and trends on the existing Siemens Building Automation system to provide the Owner with a web based graphical interface to control and monitor the installed control system.
- F. Control Sequence: A BAS pre-programmed arrangement of software algorithms, logical computation, target values and limits as required to attain the defined operational control objectives.

- G. Direct Digital Control: The digital algorithms and pre-defined arrangements included in the BAS software to provide direct closed-loop control for the designated equipment and controlled variables. Inclusive of Proportional, Derivative and Integral control algorithms together with target values, limits, logical functions, arithmetic functions, constant values, timing considerations and the like.
- H. BAS Network: The total digital on-line real-time interconnected configuration of BAS digital processing units, workstations, panels, sub-panels, controllers, devices and associated elements individually known as network nodes. May exist as one or more fully interfaced and integrated sub-networks, LAN, WAN or the like.
- I. Node: A digitally programmable entity existing on the BAS network.
- J. BAS Integration: The complete functional and operational interconnection and interfacing of all BAS work elements and nodes in compliance with all applicable codes, standards and ordinances so as to provide a single coherent BAS as required by this Division.
- K. Provide: The term "Provide" and its derivatives when used in this Division shall mean to furnish, install in place, connect, calibrate, test, commission, warrant, document and supply the associated required services ready for operation.
- L. Furnish: The term "Furnish" and its derivatives when used in this Division shall mean supply at the BAS Contractor's cost to the designated third party trade contractor for installation. BAS Contractor shall connect furnished items to the BAS, calibrate, test, commission, warrant and document.
- M. Wiring: The term "Wiring" and its derivatives when used in this Division shall mean provide the BAS wiring and terminations.
- N. Install: The term "Install" and its derivatives when used in this Division shall mean receive at the jobsite and mount.
- O. Protocol: The term "protocol" and its derivatives when used in this Division shall mean a defined set of rules and standards governing the on-line exchange of data between BAS network nodes.
- P. Software: The term "software" and its derivatives when used in this Division shall mean all of programmed digital processor software, preprogrammed firmware and project specific digital process programming and database entries and definitions as generally understood in the BAS industry for real-time, on-line, integrated BAS configurations.
- Q. The use of words in the singular in these Division documents shall not be considered as limiting when other indications in these documents denote that more than one such item is being referenced.
- R. Headings, paragraph numbers, titles, shading, bolding, underscores, clouds and other symbolic interpretation aids included in the Division documents are for general information only and are to assist in the reading and interpretation of these Documents.
- S. The following abbreviations and acronyms may be used in describing the work of this Division:
 - 1. ADC - Analog to Digital Converter
 - 2. AI - Analog Input
 - 3. AN - Application Node
 - 4. ANSI - American National Standards Institute
 - 5. AO - Analog Output
 - 6. ASCII - American Standard Code for Information Interchange
 - 7. ASHRAE - American Society of Heating, Refrigeration and Air Conditioning Engineers

8.	AWG	-	American Wire Gauge
9.	CPU	-	Central Processing Unit
10.	CRT	-	Cathode Ray Tube
11.	DAC	-	Digital to Analog Converter
12.	DDC	-	Direct Digital Control
13.	DI	-	Digital Input
14.	DO	-	Digital Output
15.	EEPROM	-	Electronically Erasable Programmable Read Only Memory
16.	EMI	-	Electromagnetic Interference
17.	FAS	-	Fire Alarm Detection and Annunciation System
18.	GUI	-	Graphical User Interface
19.	HOA	-	Hand-Off-Auto
20.	ID	-	Identification
21.	IEEE	-	Institute of Electrical and Electronics Engineers
22.	I/O	-	Input/Output
23.	LAN	-	Local Area Network
24.	LCD	-	Liquid Crystal Display
25.	LED	-	Light Emitting Diode
26.	MCC	-	Motor Control Center
27.	MS/TP	-	Master Slave / Token Passing
28.	NC	-	Normally Closed
29.	NIC	-	Not In Contract
30.	NO	-	Normally Open
31.	OWS	-	Operator Workstation
32.	OAT	-	Outdoor Air Temperature
33.	PC	-	Personal Computer
34.	PID	-	Proportional Plus Integral Plus Derivative
35.	RAM	-	Random Access Memory
36.	RF	-	Radio Frequency
37.	RFI	-	Radio Frequency Interference
38.	RH	-	Relative Humidity
39.	ROM	-	Read Only Memory
40.	RTD	-	Resistance Temperature Detector
41.	SPDT	-	Single Pole Double Throw
42.	SPST	-	Single Pole Single Throw
43.	XVGA	-	Extended Video Graphics Adapter
44.	TBA	-	To Be Advised
45.	TCP/IP	-	Transmission Control Protocol/Internet Protocol
46.	TTD	-	Thermistor Temperature Device
47.	UPS	-	Uninterruptible Power Supply
48.	VAC	-	Volts, Alternating Current
49.	VAV	-	Variable Air Volume
50.	VDC	-	Volts, Direct Current
51.	WAN	-	Wide Area Network

1.3 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.

4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F.
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F.
 - e. Ducted Air Temperature: Plus or minus 1 deg F.
 - f. Outside Air Temperature: Plus or minus 2 deg F.
 - g. Temperature Differential: Plus or minus 0.25 deg F.
 - h. Relative Humidity: Plus or minus 5 percent.
 - i. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - j. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - k. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - l. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - m. Air Pressure (Ducts): Plus or minus 0.1-inch wg.

1.4 SEQUENCES OF OPERATION

- A. Refer to drawings for sequences of operation.
 1. The sequences provided in this section are subject to minor modifications during shop drawing review phase and system start-up. These minor changes are usually due to the specific operating characteristics of the equipment actually installed and/or building dynamics. These minor sequence modifications shall be incorporated without additional charges to the Owner.
 2. All control set points called out shall be adjustable through software.

1.5 SUBMITTALS

- A. Reference section 23 05 00.
- B. Prepare an index of all products included in the submittal.
- C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
 2. Schematic flow diagrams showing but not limited to the following components: fans, pumps, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.
 4. Details of control panel faces, including controls, instruments, and labeling.
 5. Written description of sequences of operation.
 6. Schedule of dampers including size, leakage, and flow characteristics.
 - a. Include a separate line for each damper provided under this section and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Duct Size, Damper Size, Mounting, and Actuator Type.
 7. Schedule of valves including flow characteristics.
 - a. Include a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Design Pressure, and Actuator Type.
 8. Room Schedule including a separate line for each VAV box and/or terminal unit indicating location and address.
 9. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - a. Samples of Graphic Display screen types and associated menus.
 11. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
 - d. Points schedule for each point in the BAS, including: Point Type, Object Name, Expanded ID, Display Units, Controller type, and Address.
 12. Details of all BAS interfaces and connections to the work of other trades.
- E. Informational Submittals:
1. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135-2010.
- F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

1.6 MAINTENANCE MANUALS:

- A. Reference section 23 05 00. In addition to these requirements, provide the following:
1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
 2. Interconnection wiring diagrams with identified and numbered system components and devices.
 3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.
 6. Software and Firmware Operational Documentation: Include the following:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On a magnetic media or compact disc, complete with data files.
 - c. Device address list.
 - d. Printout of software application and graphic screens.
 - e. Software license required by and installed for DDC workstations and control systems.

1.7 QUALITY ASSURANCE:

- A. The BAS Contractor shall be regularly engaged in the engineering, programming, installation and service of total integrated Building Automation & Control Systems.
- B. The BAS Contractor shall be a recognized national manufacturer, installer and service provider of BAS.
- C. The BAS Contractor shall have a branch facility within a 100-mile radius of the job site supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis.
- D. As evidence and assurance of the contractor's ability to support the Owner's system with service and parts, the contractor must have been in the BAS business for at least the last ten (10) years and have successfully completed total projects of at least 10 times the value of this contract in each of the preceding five years.
- E. The Building Automation & Control System architecture shall consist of the products of a manufacturer regularly engaged in the production of Building Automation & Control Systems, and shall be the manufacturer's latest standard of design at the time of bid.
- F. All DDC system components shall comply with ASHRAE 135-2010.

2. PRODUCTS

2.1 BAS DESCRIPTION

- A. **DDC Controls Front end and graphical interface will be the Siemens DESIGO CC. The DDC controls at the building must be based on Siemens BACnet or other approved Controls Manufacturer utilizing Open BACnet Communication protocol, compatible and fully open for integration into the existing Siemens DESIGO front end. Building level BACnet control system will be integrated into the Siemens DESIGO CC system and will be the responsibility of the current Campus System Integrator (CSI) (Powers of Arkansas). The selected DDC controls provider will be responsible for the installation of the Building level control network. The Campus System Integrator will work closely with the selection DDC installation**

contractor to ensure seamless integration of the BACnet Building Control system into the Siemens DESIOG CC frontend.

All programming tools with administration access for software, controllers and field level devices must be provided to the Owner.

- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- C. Control system shall include the following:
 - 1. Application Software:
 - a. Provide interactive graphics on the BAS server with the following features:
 - 2. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
 - 3. Electronic Operation & Maintenance Manuals: The operator interface shall allow users to access electronic operation and maintenance manuals via the graphical floor plans, system schematics, menu selection, or text-based commands.
 - 4. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.
 - 5. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - 6. Graphics Definition Package
 - 7. Custom Application Software:
 - a. English language oriented.
 - b. Full-screen character editor/programming environment.
 - c. Allow development of independently executing program modules with debugging/simulation capability.
 - d. Support conditional statements.
 - e. Support floating-point arithmetic with mathematic functions.
 - f. Contains predefined time variables.
- D. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - a. Global communications.
 - b. Discrete/digital, analog, and pulse I/O.
 - c. Monitoring, controlling, or addressing data points.

- d. Software applications, scheduling, and alarm processing.
 - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
3. Standard Application Programs:
- a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
 - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
 - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
 - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
 - e. Remote communications.
 - f. Maintenance management.
 - g. Units of Measure: Inch-pound.
4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- E. The Building Automation & Control System (BAS) shall be a complete system designed for use with the existing enterprise IT system. This functionality shall extend into the equipment rooms. Devices residing on the automation network located in equipment rooms and similar shall be fully IT compatible devices that mount and communicate directly on the IT infrastructure in the facility. Contractor shall be responsible for coordination with the owner's IT staff to ensure that the BAS will perform in the owner's environment without disruption to any of the other activities taking place on that LAN.
- F. All points of user interface shall be on standard PCs that do not require the purchase of any special software from the BAS manufacturer for use as a building operations terminal. The primary point of interface on these PCs will be a standard Web Browser.
- G. All archiving of system configuration data and historical data such as trend data and operator transactions shall be performed utilizing the existing Siemens Control system server on the UAPB Campus. All data stored will be through the use of a standard data base platform: Microsoft SQL Server Express or Microsoft SQL Server as dictated elsewhere in this specification.
- H. The work of the single BAS Contractor shall be as defined individually and collectively in all Sections of this Division specifications together with the associated Point Sheets and Drawings and the associated interfacing work as referenced in the related documents.
- I. The BAS work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching, warranties, services, and items, even though these may not be specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned BAS.

- J. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software, standards and configurations to be provided for this Project.
- K. Manage and coordinate the BAS work in a timely manner in consideration of the Project schedules. Coordinate with the associated work of other trades so as to not impede or delay the work of associated trades.
- L. The BAS as provided shall incorporate, at minimum, the following integrated features, functions and services:
 - 1. Operator information, alarm management and control functions.
 - 2. Enterprise-level information and control access.
 - 3. Information management including monitoring, transmission, archiving, retrieval, and reporting functions.
 - 4. Diagnostic monitoring and reporting of BAS functions.
 - 5. Offsite monitoring and management access.
 - 6. Energy management
 - 7. Standard applications for terminal HVAC systems.
 - 8. Indoor Air Quality monitoring and control

2.2 QUALITY ASSURANCE

A. Workplace Safety and Hazardous Materials

- 1. Provide a safety program in compliance with the Contract Documents.
- 2. The BAS Contractor shall have a corporately certified comprehensive Safety Certification Manual and a designated Safety Supervisor for the Project.
- 3. The Contractor and its employees and subtrades comply with federal, state and local safety regulations.
- 4. The Contractor shall ensure that all subcontractors and employees have written safety programs in place that covers their scope of work, and that their employees receive the training required by the OSHA have jurisdiction for at least each topic listed in the Safety Certification Manual.
- 5. Hazards created by the Contractor or its subcontractors shall be eliminated before any further work proceeds.
- 6. Hazards observed but not created by the Contractor or its subcontractors shall be reported to either the General Contractor or the Owner within the same day. The Contractor shall be required to avoid the hazard area until the hazard has been eliminated.
- 7. The Contractor shall sign and date a safety certification form prior to any work being performed, stating that the Contractors' company is in full compliance with the Project safety requirements.
- 8. The Contractor's safety program shall include written policy and arrangements for the handling, storage and management of all hazardous materials to be used in the work in compliance with the requirements of the AHJ at the Project site.
- 9. The Contractor's employees and subcontractor's staff shall have received training as applicable in the use of hazardous materials and shall govern their actions accordingly.

B. Quality Management Program

- 1. Designate a competent and experienced employee to provide BAS Project Management. The designated Project Manager shall be empowered to make technical, scheduling and related decisions on behalf of the BAS Contractor. At minimum, the Project Manager shall:
 - a. Manage the scheduling of the work to ensure that adequate materials, labor and other resources are available as needed.
 - b. Manage the financial aspects of the BAS Contract.

- c. Coordinate as necessary with other trades.
- d. Be responsible for the work and actions of the BAS workforce on site.

2.3 WORK BY OTHERS

- A. The contractor shall be responsible for outlining the demarcation of work and responsibilities between the BAS Contractor and other related trades.

2.4 SUBMITTALS

2.5 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media, and include the following for the BAS provided:
 - a. Table of contents.
 - b. As-built system record drawings. Computer Aided Drawings (CAD) record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.
 - c. Manufacturers product data sheets or catalog pages for all products including software.
 - d. System Operator's manuals.
 - e. Archive copy of all site-specific databases and sequences.
 - f. BAS network diagrams.
 - g. Interfaces to all third-party products and work by other trades.
2. The Operation and Maintenance Manual CD shall be self-contained, and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom, and search all documents.

2.6 WARRANTY

A. Standard Material and Labor Warranty:

1. Provide a one-year labor and material warranty on the BAS.
2. If within twelve (12) months from the date of acceptance of product, upon written notice from the owner, it is found to be defective in operation, workmanship or materials, it shall be replaced, repaired or adjusted at the option of the BAS Contractor at the cost of the BAS Contractor.
3. Maintain an adequate supply of materials within 100 miles of the Project site such that replacement of key parts and labor support, including programming. Warranty work shall be done during BAS Contractor's normal business hours.

3. PRODUCTS

3.1 GENERAL DESCRIPTION

- A. The Building Automation & Control System (BAS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BAS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.
- B. The Building Automation & Control System shall consist of the following:
 - 1. Standalone Network Automation Engine(s)
 - 2. Field Equipment Controller(s)
 - 3. Input/Output Module(s)
 - 4. Distributed User Interface(s)
 - 5. Network processing, data storage and communications equipment
 - 6. Other components required for a complete and working BAS
- C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.
- D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
 - 1. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
 - 2. The System shall maintain all settings and overrides through a system reboot.
- E. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
- F. Acceptable Manufacturers
 - 1. **Siemens BACnet**
 - 2. **Or approved Manufacturer utilizing Open BACnet Communication Protocol**

3.2 USER INTERFACE

- A. Distributed Web Based User Interface
 - 1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
- B. User Interface Application Components
 - 1. Operator Interface
 - a. An integrated browser based client application shall be used as the user operator interface program.
 - b. The System shall employ an event-driven rather than a device polling methodology to dynamically capture and present new data to the user.
 - c. All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.

- d. The user interface software shall provide help menus and instructions for each operation and/or application.
- e. The system shall support customization of the UI configuration and a home page display for each operator.
- f. The system shall support user preferences in the following screen presentations:
 - 1) Alarm
 - 2) Trend
 - 3) Display
 - 4) Applications
- g. All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints, alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.
- h. The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:
 - 1) User access for selective information retrieval and control command execution
 - 2) Monitoring and reporting
 - 3) Alarm, non-normal, and return to normal condition annunciation
 - 4) Selective operator override and other control actions
 - 5) Information archiving, manipulation, formatting, display and reporting
 - 6) BAS internal performance supervision and diagnostics
 - 7) On-line access to user HELP menus
 - 8) On-line access to current BAS as-built records and documentation
 - 9) Means for the controlled re-programming, re-configuration of BAS operation and for the manipulation of BAS database information in compliance with the prevailing codes, approvals and regulations for individual BAS applications
- i. The system shall support a list of application programs configured by the users that are called up by the following means:
 - 1) The Tools Menu
 - 2) Hyperlinks within the graphics displays
 - 3) Key sequences
- j. The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2. Navigation Trees

- a. The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.
- b. Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.
- c. The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

3. Alarms

- a. Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:
 - 1) Log date and time of alarm occurrence.
 - 2) Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
 - 3) Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
 - 4) Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
 - 5) Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
 - 6) Any attribute of any object in the system may be designated to report an alarm.
 - b. The BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.
 - c. The BAS shall allow a minimum of 4 categories of alarm sounds customizable through user defined wav.files.
 - d. The BAS shall annunciate application alarms at minimum, as required by Part 3.
4. Reports and Summaries
- a. Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:
 - 1) All points in the BAS
 - 2) All points in each BAS application
 - 3) All points in a specific controller
 - 4) All points in a user-defined group of points
 - 5) All points currently in alarm
 - 6) All points locked out
 - 7) All BAS schedules
 - 8) All user defined and adjustable variables, schedules, interlocks and the like.
 - b. Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
 - c. Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
 - d. The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.
5. Schedules
- a. A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:
 - 1) Weekly schedules
 - 2) Exception Schedules

3) Monthly calendars

- b. Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
- c. It shall be possible to define one or more exception schedules for each schedule including references to calendars
- d. Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
- e. Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
- f. Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
- g. Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

6. Password

- a. Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
- b. Each user shall have the following: a user name (accept 24 characters minimum), a password (accept 12 characters minimum), and access levels.
- c. The system shall allow each user to change his or her password at will.
- d. When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
- e. A minimum of five levels of access shall be supported individually or in any combination as follows:
 - 1) Level 1 = View Data
 - 2) Level 2 = Command
 - 3) Level 3 = Operator Overrides
 - 4) Level 4 = Database Modification
 - 5) Level 5 = Database Configuration
 - 6) Level 6 = All privileges, including Password Add/Modify
- f. A minimum of 100 unique passwords shall be supported.
- g. Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
- h. The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

7. Screen Manager

- a. The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

8. Dynamic Color Graphics

- a. The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

- b. The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.
 - 1) The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.
 - c. Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:
 - 1) All graphics shall be fully scalable
 - 2) The graphics shall support a maintained aspect ratio.
 - 3) Multiple fonts shall be supported.
 - 4) Unique background shall be assignable on a per graphic basis.
 - 5) The color of all animations and values on displays shall indicate if the status of the object attribute.
 - d. Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device
 - e. Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.
 - 1) The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
 - 2) In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.
 - f. Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.
9. Historical trending and data collection
- a. Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:
 - 1) Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:
 - a) Defined time interval
 - b) Upon a change of value
 - 2) Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

- b. Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.
- c. The system shall provide a configurable data storage subsystem for the collection of historical data. Data can be stored in either Microsoft Access or SQL database format.

10. Trend data viewing and analysis

- a. Provide a trend viewing utility that shall have access to all database points.
- b. It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
- c. The trend viewing utility shall have the capability to define trend study displays to include multiple trends
- d. Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
- e. Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
- f. Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
- g. Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.
- h. The Display shall support the user's ability to change colors, sample sizes, and types of markers.

11. Database Management

- a. Where a separate SQL database is utilized for information storage the System shall provide a Database Manager that separates the database monitoring and managing functions by supporting two separate windows.
- b. Database secure access shall be accomplished using standard SQL authentication including the ability to access data for use outside of the Building Automation application.
- c. The database managing function shall include summarized information on trend, alarm, event, and audit for the following database management actions:
 - 1) Backup
 - 2) Purge
 - 3) Restore
- d. The Database Manager shall support four tabs:
 - 1) Statistics – shall display Database Server information and Trend, Alarm (Event), and Audit information on the Metasys Databases.
 - 2) Maintenance – shall provide an easy method of purging records from the Metasys Server trend, alarm (event), and audit databases by supporting separate screens for creating a backup prior to purging, selecting the database, and allowing for the retention of a selected number of day's data.
 - 3) Backup – Shall provide the means to create a database backup file and select a storage location.
 - 4) Restore – shall provide a restricted means of restoring a database by requiring the user to log into an Expert Mode in order to view the Restore screen.
- e. The Status Bar shall appear at the bottom of all Metasys Database Manager Tabs and shall provide information on the current database activity. The following icons shall be provided:

- 1) Ready
- 2) Purging Record from a database
- 3) Action Failed
- 4) Refreshing Statistics
- 5) Restoring database
- 6) Shrinking a database
- 7) Backing up a database
- 8) Resetting internet information Services
- 9) Starting the Metasys Device Manager
- 10) Shutting down the Metasys Device Manager
- 11) Action successful

- f. The Database Manager monitoring functions shall be accessed through the Monitoring Settings window and shall continuously read database information once the user has logged in.
- g. The System shall provide user notification via taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.
- h. The Monitoring Settings window shall have the following sections:
 - 1) General – Shall allow the user to set and review scan intervals and start times.
 - 2) Email – Shall allow the user to create and review e-mail and phone text messages to be delivered when a Warning or Alarm is generated.
 - 3) Warning – shall allow the user to define the Warning limit parameters, set the Reminder Frequency, and link the e-mail message.
 - 4) Alarm – shall allow the user to define the Alarm limit parameters, set the Reminder Frequency, and link the e-mail message.
 - 5) Database login – Shall protect the system from unauthorized database manipulation by creating a Read Access and a Write Access for each of the Trend, Alarm (Event) and Audit databases as well as an Expert Mode required to restore a database.
- i. The Monitoring Settings Taskbar shall provide the following informational icons:
 - 1) Normal – Indicates by color and size that all databases are within their limits.
 - 2) Warning - Indicates by color and size that one or more databases have exceeded their Warning limit.
 - 3) Alarm - Indicates by color and size that one or more databases have exceeded their Alarm limit.
- j. The System shall provide user notification via Taskbar icons and e-mail messages when a database value has exceeded a warning or alarm limit.

12. Demand Limiting and Load Rolling

- a. The System shall provide a Demand Limiting and Load Rolling program for the purpose of limiting peak energy usage and reducing overall energy consumption.
- b. The System shall support both Sliding Window and Fixed Window methods of predicting demand.
- c. The System shall support three levels of sensitivity in the Sliding Window demand calculations for fine tuning the system.
 - 1) Low Setting – Sheds loads later and over the shortest amount of time. Maximizes the time the equipment is on.
 - 2) Medium Setting – Sheds loads earlier over a longer amount of time than the Low Setting. Increases the time the equipment is on and decreases the probability of exceeding the Tariff Target over the Low Setting.

- 3) High Setting – Sheds loads earlier over a longer amount of time than the Medium Setting. Minimizes the probability of exceeding the Tariff Target.
- d. The System shall have both a Shed Mode and a Monitor Only Mode of operation.
 - 1) When the Shed Mode is engaged, the System shall actively control the Demand.
 - 2) When the Monitor Mode is engaged, the System will simulate the shedding action but will not take any action.
 - e. The Demand Limiting program shall monitor the energy consumption rate and compare it to a user defined Tariff Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined strategy.
 - f. The Demand Limiting program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
 - g. The Demand Limiting program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the maximum allowed average power during the current interval.
 - h. The System shall support a Maximum Shed Time for each load as determined by the user. The system shall restore the load before the Maximum Shed time has expired.
 - i. The System shall support a Minimum Shed Time for each load as determined by the user. The system shall not restore the load sooner than the Minimum Shed Time has expired.
 - j. The System shall support a Minimum Release Time for each load as determined by the user. The System shall not shed the load until it has been off for the Minimum Release time.
 - k. The System shall support three user defined options if the meter goes unreliable.
 - 1) Shedding – The currently shed loads will be released as their Maximum shed Times expire.
 - 2) Maintain the Current Shed Rate – The System will use the Demand Limiting shed rate that was present when the meter went unreliable.
 - 3) Use Unreliable Meter Shed Rate – the system will control to a user defined Unreliable Shed Rate target.
 - l. The Load Rolling program shall sum the loads currently shed and compare it to a user defined Load Rolling Target. The system shall maintain consumption below the target by selectively shedding loads based upon a user defined Load Priority.
 - m. The Load Rolling program shall be capable of supporting a minimum of 10 separate Load Priorities. Each load shall be user assigned to a Load Priority.
 - n. The Load Rolling program shall be capable of supporting a minimum of 12 separate Tariff Targets defining the amount of power by which the demand must be reduced.
 - o. The System shall provide the user with a Load Tab that displays all of the Demand Limiting and Load Rolling parameters for any selected load.
 - p. The System shall provide the user with a Load Summary that displays all of the loads associated with the Demand Limiting and Load Rolling programs. Status Icons for each load shall indicate:
 - 1) Load is Offline
 - 2) Load is Disabled
 - 3) Load is Shed
 - 4) Load is Locked
 - 5) Load is in Comfort Override
 - q. The Load Summary shall include a Load Summary Runtime view listing the following load conditions:
 - 1) Load Priority

- 2) Shed Strategy
- 3) Load Rating
- 4) Present Value
- 5) Ineligibility Status
- 6) Active Timer
- 7) Time Remaining
- 8) Last Shed Time

DDC SYSTEM CONTROLLERS

C. Field Equipment Controller

1. The Field Equipment Controller (FEC) shall be a fully user-programmable, digital controller that communicates via BACnet MS/TP protocol.
 - a. The FEC shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - 1) The FEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - 2) The FEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - 3) A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
 - 4) The Conformance Statement shall be submitted 10 days prior to bidding.
2. The FEC shall employ a finite state control engine to eliminate unnecessary conflicts between control functions at crossover points in their operational sequences. Suppliers using non-state based DDC shall provide separate control strategy diagrams for all controlled functions in their submittals.
3. Controllers shall be factory programmed with a continuous adaptive tuning algorithm that senses changes in the physical environment and continually adjusts loop tuning parameters appropriately. Controllers that require manual tuning of loops or perform automatic tuning on command only shall not be acceptable.
4. The FEC shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
5. The FEC shall include a removable base to allow pre-wiring without the controller.
6. The FEC shall include troubleshooting LED indicators to identify the following conditions:
 - a. Power On
 - b. Power Off
 - c. Download or Startup in progress, not ready for normal operation
 - d. No Faults
 - e. Device Fault

- f. Field Controller Bus - Normal Data Transmission
 - g. Field Controller Bus - No Data Transmission
 - h. Field Controller Bus - No Communication
 - i. Sensor-Actuator Bus - Normal Data Transmission
 - j. Sensor-Actuator Bus - No Data Transmission
 - k. Sensor-Actuator Bus - No Communication
7. The FEC shall accommodate the direct wiring of analog and binary I/O field points.
8. The FEC shall support the following types of inputs and outputs:
- a. Universal Inputs - shall be configured to monitor any of the following:
 - 1) Analog Input, Voltage Mode
 - 2) Analog Input, Current Mode
 - 3) Analog Input, Resistive Mode
 - 4) Binary Input, Dry Contact Maintained Mode
 - 5) Binary Input, Pulse Counter Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - 1) Dry Contact Maintained Mode
 - 2) Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following
 - 1) Analog Output, Voltage Mode
 - 2) Analog Output, current Mode
 - d. Binary Outputs - shall output the following:
 - 1) 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:
 - 1) Analog Output, Voltage Mode
 - 2) Binary Output Mode
9. The FEC shall have the ability to reside on a Field Controller Bus (FC Bus).
- a. The FC Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard protocol SSPC-135, Clause 9.
 - b. The FC Bus shall support communications between the FECs and the NAE.
 - c. The FC Bus shall also support Input/Output Module (IOM) communications with the FEC and with the NAE.
 - d. The FC Bus shall support a minimum of 100 IOMs and FECs in any combination.
 - e. The FC Bus shall operate at a maximum distance of 15,000 Ft. between the FEC and the furthest connected device.
 - f.
10. The FEC shall have the ability to monitor and control a network of sensors and actuators over a Sensor-Actuator Bus (SA Bus).
- a. The SA Bus shall be a Master-Slave/Token-Passing (MS/TP) Bus supporting BACnet Standard Protocol SSPC-135, Clause 9.
 - b. The SA Bus shall support a minimum of 10 devices per trunk.

- c. The SA Bus shall operate at a maximum distance of 1,200 Ft. between the FEC and the furthest connected device.
- 11. The FEC shall have the capability to execute complex control sequences involving direct wired I/O points as well as input and output devices communicating over the FC Bus or the SA Bus.
- 12. The FEC shall support, but not be limited to, the following:
 - a. Hot water, chilled water/central plant applications
 - b. Built-up air handling units for special applications
 - c. Terminal units
 - d. Special programs as required for systems control

D. Input/Output Module

- 1. The Input/Output Module (IOM) provides additional inputs and outputs for use in the FEC.
- 2. The IOM shall communicate with the FEC over the FC Bus or the SA Bus.
- 3. The IOM shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.
 - a. The IOM shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - b. The IOM shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - c. A BACnet Protocol Implementation Conformance Statement shall be provided for the FEC.
 - d. The Conformance Statement shall be submitted 10 days prior to bidding.
- 4. The IOM shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
- 5. The IOM shall have a minimum of 4 points to a maximum of 17 points.
- 6. The IOM shall support the following types of inputs and outputs:
 - a. Universal Inputs - shall be configured to monitor any of the following:
 - 1) Analog Input, Voltage Mode
 - 2) Analog Input, Current Mode
 - 3) Analog Input, Resistive Mode
 - 4) Binary Input, Dry Contact Maintained Mode
 - 5) Binary Input, Pulse Counter Mode
 - b. Binary Inputs - shall be configured to monitor either of the following:
 - 1) Dry Contact Maintained Mode
 - 2) Pulse Counter Mode
 - c. Analog Outputs - shall be configured to output either of the following
 - 1) Analog Output, Voltage Mode
 - 2) Analog Output, current Mode
 - d. Binary Outputs - shall output the following:
 - 1) 24 VAC Triac
 - e. Configurable Outputs - shall be capable of the following:

- 1) Analog Output, Voltage Mode
- 2) Binary Output Mode

7. The IOM shall include troubleshooting LED indicators to identify the following conditions:

- a. Power On
- b. Power Off
- c. Download or Startup in progress, not ready for normal operation
- d. No Faults
- e. Device Fault
- f. Normal Data Transmission
- g. No Data Transmission
- h. No Communication

E. Networked Thermostat

1. The networked thermostat shall be capable of controlling two- or four-pipe fan coils, cabinet unit heaters or other similar equipment.
2. The TEC shall communicate over the Field Controller Bus using BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
3. The TEC shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The TEC shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the TEC.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
4. The Networked Thermostat shall support remote read/write and parameter adjustment from the web based User Interfaceable through a Network Automation Engine.
5. The Networked Thermostat shall include an intuitive User Interface providing plain text messages.
 - a. Two line, 8 character backlit display
 - b. LED indicators for Fan, Heat, and Cool status
 - c. Five (5) User Interface Keys
 - 1) Mode
 - 2) Fan
 - 3) Override
 - 4) Degrees C/F
 - 5) Up/Down
 - d. The display shall continuously scroll through the following parameters:
 - 1) Room Temperature
 - 2) System Mode
 - 3) Schedule Status – Occupied/Unoccupied/Override
 - 4) Applicable Alarms
6. The Networked Thermostat shall provide the flexibility to support any one of the following inputs:
 - a. Integral Indoor Air Temperature Sensor
 - b. Duct Mount Air Temperature Sensor
 - c. Remote Indoor Air Temperature Sensor with Occupancy Override and LED Indicator

- d. Two configurable binary inputs
7. The Networked Thermostat shall provide the flexibility to support any one of the following outputs:
 - a. Three Speed Fan Control
 - b. Two On/Off
 - c. Two Floating
 - d. Two Proportional (0 to 10V)
 8. The Networked Thermostat shall provide a minimum of six (6) levels of keypad lockout.
 9. The Networked Thermostat shall provide the flexibility to adjust the following parameters:
 - a. Adjustable Temporary Occupancy from 0 to 24 hours
 - b. Adjustable heating/cooling deadband from 2° F to 5° F
 - c. Adjustable heating/cooling cycles per hour from 4 to 8
 10. The Networked Thermostat shall employ nonvolatile electrically erasable programmable read-only memory (EEPROM) for all adjustable parameters.

F. VAV Modular Assembly

1. The VAV Modular Assembly shall provide both standalone and networked direct digital control of pressure-independent, variable air volume terminal units. It shall address both single and dual duct applications.
2. The VMA shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The VMA shall be tested and certified as a BACnet Application Specific Controller (B-ASC).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the VMA.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
3. The VAV Modular Assembly shall communicate over the FC Bus using BACnet Standard protocol SSPC-135, Clause 9.
4. The VAV Modular Assembly shall have internal electrical isolation for AC power, DC inputs, and MS/TP communications. An externally mounted isolation transformer shall not be acceptable.
5. The VAV Modular Assembly shall be a configurable digital controller with integral differential pressure transducer and damper actuator. All components shall be connected and mounted as a single assembly that can be removed as one piece.
6. The VAV Modular Assembly shall be assembled in a plenum-rated plastic housing with flammability rated to UL94-5VB.
7. The integral damper actuator shall be a fast response stepper motor capable of stroking 90 degrees in 30 seconds for quick damper positioning to speed commissioning and troubleshooting tasks.
8. The controller shall determine airflow by dynamic pressure measurement using an integral dead-ended differential pressure transducer. The transducer shall be maintenance-free and shall not require air filters.
9. Each controller shall have the ability to automatically calibrate the flow sensor to eliminate pressure transducer offset error due to ambient temperature / humidity effects.
10. The controller shall utilize a proportional plus integration (PI) algorithm for the space temperature control loops.
11. Each controller shall continuously, adaptively tune the control algorithms to improve control and controller reliability through reduced actuator duty cycle. In addition, this tuning reduces commissioning costs, and eliminates the maintenance costs of manually re-tuning loops to compensate for seasonal or other load changes.

12. The controller shall provide the ability to download and upload VMA configuration files, both locally and via the communications network. Controllers shall be able to be loaded individually or as a group using a zone schedule generated spreadsheet of controller parameters.
13. Control setpoint changes initiated over the network shall be written to VMA non-volatile memory to prevent loss of setpoint changes and to provide consistent operation in the event of communication failure.
14. The controller firmware shall be flash-upgradeable remotely via the communications bus to minimize costs of feature enhancements.
15. The controller shall provide fail-soft operation if the airflow signal becomes unreliable, by automatically reverting to a pressure-dependent control mode.
16. The controller shall interface with balancer tools that allow automatic recalculation of box flow pickup gain ("K" factor), and the ability to directly command the airflow control loop to the box minimum and maximum airflow setpoints.
17. Controller performance shall be self-documenting via on-board diagnostics. These diagnostics shall consist of control loop performance measurements executing at each control loop's sample interval, which may be used to continuously monitor and document system performance. The VMA shall calculate exponentially weighted moving averages (EWMA) for each of the following. These metrics shall be available to the end user for efficient management of the VAV terminals.
 - 1) Absolute temperature loop error
 - 2) Signed temperature loop error
 - 3) Absolute airflow loop error
 - 4) Signed airflow loop error
 - 5) Average damper actuator duty cycle
18. The controller shall detect system error conditions to assist in managing the VAV zones. The error conditions shall consist of:
 - 1) Unreliable space temperature sensor
 - 2) Unreliable differential pressure sensor
 - 3) Starved box
 - 4) Actuator stall
 - 5) Insufficient cooling
 - 6) Insufficient heating
 - b. The controller shall provide a flow test function to view damper position vs. flow in a graphical format. The information would alert the user to check damper position. The VMA would also provide a method to calculate actuator duty cycle as an indicator of damper actuator runtime.
19. The controller shall provide a compliant interface for ASHRAE Standard 62-2007 (indoor air quality), and shall be capable of resetting the box minimum airflow Based on the percent of outdoor air in the primary air stream.
20. The controller shall comply with ASHRAE Standard 90.1-2007 (energy efficiency) by preventing simultaneous heating and cooling, and where the control strategy requires reset of airflow while in reheat, by modulating the box reheat device fully open prior to increasing the airflow in the heating sequence.
21. Inputs:
 - a. Analog inputs with user defined ranges shall monitor the following analog signals, without the addition of equipment outside the terminal controller cabinet:
 - 1) 0-10 VDC Sensors
 - 2) 1000ohm RTDs
 - 3) NTC Thermistors

- b. Binary inputs shall monitor dry contact closures. Input shall provide filtering to eliminate false signals resulting from input "bouncing."
- c. For noise immunity, the inputs shall be internally isolated from power, communications, and output circuits.
- d. Provide side loop application for humidity control.

22. Outputs

- a. Analog outputs shall provide the following control outputs:
 - 1) 0-10 VDC
- b. Binary outputs shall provide a SPST Triac output rated for 500mA at 24 VAC.
- c. For noise immunity, the outputs shall be internally isolated from power, communications, and other output circuits.

3.3 APPLICATION CONFIGURATION

- A. The VAV Modular Assembly shall be configured with a software tool that provides a simple Question/Answer format for developing applications and downloading.

3.4 SENSOR SUPPORT

- A. The VAV Modular Assembly shall communicate over the Sensor-Actuator Bus (SA Bus) with a Network Sensor.
- B. The VMA shall support an LCD display room sensor.
- C. The VMA shall also support standard room sensors as defined by analog input requirements.
- D. The VMA shall support humidity sensors defined by the AI side loop.
- E. Network Sensors

- 1. The Network Sensors (NS) shall have the ability to monitor the following variables as required by the systems sequence of operations:
 - a. Zone Temperature
 - b. Zone Humidity
 - c. Zone Setpoint
 - d. Discharge Air Temperature
- 2. The NS shall transmit the information back to the controller on the Sensor-Actuator Bus (SA Bus) using BACnet Standard protocol SSPC-135, Clause 9.
- 3. The NS shall be BACnet Testing Labs (BTL) certified and carry the BTL Label.
 - a. The NS shall be tested and certified as a BACnet Smart Sensors (B-SS).
 - b. A BACnet Protocol Implementation Conformance Statement shall be provided for the NS.
 - c. The Conformance Statement shall be submitted 10 days prior to bidding.
- 4. The Network Zone Sensors shall include the following items:

- a. A backlit Liquid Crystal Display (LCD) to indicate the Temperature, Humidity and Setpoint
 - b. An LED to indicate the status of the Override feature
 - c. A button to toggle the temperature display between Fahrenheit and Celsius
 - d. A button to initiate a timed override command
 - e. Available in either surface mount or wall mount
 - f. Available with either screw terminals or phone jack
5. The Network Discharge Air Sensors shall include the following:
- a. 4 inch or 8 inch duct insertion probe
 - b. 10 foot pigtail lead
 - c. Dip Switches for programmable address selection
 - d. Ability to provide an averaging temperature from multiple locations
 - e. Ability to provide a selectable temperature from multiple locations

3.5 SYSTEM TOOLS

A. System Configuration Tool (SCT)

- 1. The Configuration Tool software is existing and shall be used for this project. All passwords and administrative access levels will be provided to the Owner for this system.
 - a. The sensor shall provide an adjustable time-out parameter that will return the controller to normal operation if the balancing operation is aborted or abandoned.
 - b. The sensor shall include the following
 - 1) 5 foot retractable cable
 - 2) Laminated user guide
 - 3) Nylon carrying case
 - c. The sensor shall be Underwriters Laboratory UL 916 listed and CSA certified C22.2 N. 205, CFR47.

3.6 MAINTENANCE / WARRANTY SERVICE

- A. Standard warranty is twenty-four (24) months from the date of shipment and covers the factory repair or replacement of the defective unit.
- B. Warranty is thirty-six (36) months from date of shipment when an authorized service representative performs start up and includes parts, labor and travel time.
- C. Local Control Panels
 - 1. All control panels shall be factory constructed, incorporating the BAS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door, and slotted flush latch.
 - 2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices—such as relays, transducers, and so forth—that are not required to be located external to the control panel due to function. Where specified the display module shall be flush mounted in the panel face unless otherwise noted.
 - 3. All I/O connections on the DDC controller shall be provide via removable or fixed screw terminals.

4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed 300-volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 VAC duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

D. Power Supplies

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 VAC +10%, 60Hz.
3. Output: 24 VDC.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

E. Thermostats

1. Electric room thermostats of the heavy-duty type shall be provided for unit heaters, cabinet unit heaters, and ventilation fans, where required. All these items shall be provided with concealed adjustment. Finish of covers for all room-type instruments shall match and, unless otherwise indicated or specified, covers shall be manufacturer's standard finish.

4. EXECUTION

4.1 BAS SPECIFIC REQUIREMENT

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Custom Reports:

1. Provide custom reports as required for this project:

C. Actuation / Control Type

1. Primary Equipment

- a. Controls shall be provided by equipment manufacturer as specified herein.
- b. All damper and valve actuation shall be electric.

2. Terminal Equipment:

- a. Terminal Units (VAV, UV, etc.) shall have electric damper and valve actuation.
- b. All Terminal Units shall be controlled with HVAC-DDC Controller.

4.2 INSTALLATION PARCTICES

A. BAS Wiring

1. All conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified, shall be provided by the BAS Contractor unless specifically shown on the Electrical Drawings under Division 16 Electrical. All wiring shall comply with the requirements of applicable portions of Division 16 and all local and national electric codes, unless specified otherwise in this section.
2. All BAS wiring materials and installation methods shall comply with BAS manufacturer recommendations.
3. The sizing, type and provision of cable, conduit, cable trays, and raceways shall be the design responsibility of the BAS Contractor. If complications arise, however, due to the incorrect selection of cable, cable trays, raceways and/or conduit by the BAS Contractor, the Contractor shall be responsible for all costs incurred in replacing the selected components.
4. Class 2 Wiring
 - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified below.
 - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5' from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements.
5. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.
6. Provide for complete grounding of all applicable signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. BAS Line Voltage Power Source

1. 120-volt AC circuits used for the Building Management System shall be taken from panel boards and circuit breakers provided by Division 26.
2. Circuits used for the BAS shall be dedicated to the BAS and shall not be used for any other purposes.
3. DDC terminal unit controllers may use AC power from motor power circuits.
4. Coordinate all connections to Division 26 work with Division 26 contractor.

C. BAS Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size shall be 1/2".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.
4. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

D. Penetrations

1. Provide fire stopping for all penetrations used by dedicated BAS conduits and raceways.
2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

3. All wiring passing through penetrations, including walls shall be in conduit or enclosed raceway.
4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

E. BAS Identification Standards

1. Node Identification. All nodes shall be identified by a permanent label fastened to the enclosure. Labels shall be suitable for the node location.
 - a. Cable types specified in Item A shall be color coded for easy identification and troubleshooting.

F. BAS Panel Installation

1. The BAS panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
2. The BAS contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

G. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BAS in accessible local control panels wherever possible.

H. HVAC Input Devices – General

1. All Input devices shall be installed per the manufacturer recommendation
2. Locate components of the BAS in accessible local control panels wherever possible.
3. The mechanical contractor shall install all in-line devices such as temperature wells, pressure taps, airflow stations, etc.
4. Input Flow Measuring Devices shall be installed in strict compliance with ASME guidelines affecting non-standard approach conditions.
5. Outside Air Sensors
 - a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
 - b. Sensors shall be installed with a rain proof, perforated cover.
6. Space Sensors:
 - a. Shall be mounted per ADA requirements.
 - b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.
7. Air Differential Pressure Status Switches:
 - a. Install with static pressure tips, tubing, fittings, and air filter.

I. HVAC Output Devices

1. All output devices shall be installed per the manufacturers' recommendation. The mechanical contractor shall install all in-line devices such as control valves, dampers, airflow stations, pressure wells, etc.
2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.
3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.
4. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems

4.3 SEQUENCES OF OPERATION AND POINTS LISTS

- A. Refer to project plans for sequences of operation and points lists.

END OF SECTION

SECTION 23 09 01 - INSTRUMENTS AND CONTROL ELEMENTS

1. GENERAL

1.1 SECTION INCLUDES

- A. Control dampers.
- B. Actuators: control dampers.
- C. Electronic sensors.
- D. Status sensors.
- E. Control wiring.
- F. Miscellaneous accessories.

1.2 SYSTEM DESCRIPTION

- A. The temperature control system for this project shall utilize all electric relays, actuators, etc. for all controlled devices.
- B. Provide complete and operational system of instruments and control elements and accessories as necessary required to operate mechanical systems, fulfill the intent of the plans and specifications and provide operating sequence as specified.

1.3 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. QUALITY ASSURANCE
- B. REFERENCES
- C. SUBMITTALS

- 1. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
- 2. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve.
- 3. Label each control device with setting or adjustable range of control.
- 4. All required electrical wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
- 5. Submit leakage and flow characteristics, plus size schedule for control dampers.

- D. PROJECT RECORD DOCUMENTS / OPERATION AND MAINTENANCE MANUALS

1. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors and include in Maintenance Manuals. Revise shop drawings to reflect actual installation and operating sequences prior to including in Maintenance Manuals.
2. Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances in Maintenance Manuals.

E. DELIVERY, STORAGE, AND HANDLING

F. WARRANTY

1. Submit manufacturers warranty and ensure forms have been filled out in Owners name and registered with manufacturer.

G. COORDINATION

1. All products listed in this specification section shall be coordinated with other trades prior to installation to ensure that all manufacturer requirements for installation (i.e. inlet/outlet distances, mounting locations, etc) have been satisfied. No additional compensation shall be awarded for controls component relocation due to lack of coordination.
 - a. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
 - b. Coordinate equipment with Fire Detection and Alarm systems to achieve compatibility with equipment that interfaces with that system.
 - c. Unless otherwise shown, the Controls Contractor shall provide all necessary 120-volt power as required for the control system and control components. Provide circuits to each location from the nearest available standby or normal panelboard. Coordinate with Electrical Contractor. Refer to Division 26 specifications for product and installation requirements.
2. The manufacturer's authorized representative shall review and approve placement for each component location indicated on the plans, prior to installation. A written report shall be submitted to the engineer if any locations do not meet the manufacturer's placement requirements.

1.4 MAINTENANCE SERVICE

- A. Provide service and maintenance of control system for one year from Date of Substantial Completion.
- B. Provide complete service of controls systems, including call backs. Make minimum of 2 complete normal inspections at start of heating and cooling seasons to inspect, calibrate, and adjust controls, and submit written reports. Coordinate with commissioning plan.

2. PRODUCTS

2.1 CONTROL DAMPERS

- A. TAMCO 1500 or 9000SC or equivalent, unless scheduled differently on the Drawings.

1. Damper shall meet the leakage requirements of the International Energy Conservation Code by leaking less than 3 CFM/SF at 1" of static pressure and shall be AMCA licensed as a class 1A damper.
 2. Frame: 16 gage galvanized steel structural hat channel with tabbed corners for reinforcement for 11 gage structural equivalence.
 3. Blades: 14 gage equivalent thickness aluminum, roll-formed airfoil type for low pressure drop and low noise generation. Blade edge seals shall be silicone suitable for -72 deg F to 275 deg F and shall be mechanically locked into the blade edge.
 - a. Provide parallel blades for 2-position control.
 - b. Provide opposed blades for modulating control.
 - c. Provide internally insulated blades for outside air applications or other applications used in cold temperatures. Blade assembly shall have a minimum R-value of 2.29.
 4. Frame seals: Silicone to prevent leakage between blade end and damper frame. Blade end overlapping frame is unacceptable.
 5. Bearings shall be corrosion resistant, permanently lubricated stainless steel sleeve type or aluminum/synthetic type turning in an outer bearing in the damper frame.
 6. Axles: Axles shall be hexagonal positively locked into the damper blade.
 7. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure drop and noise.
- B. Provide multiple sections and operators as required by opening size and sequence of operations, as indicated on the contract drawings.

2.2 ACTUATORS FOR CONTROL DAMPERS

- A. Manufacturer: Belimo or equivalent.
- B. Size for torque required for damper seal at design load conditions. Exact size and type of actuators shall be determined from damper manufacturer's torque requirements, close-off ratings, system parameters, etc.
- C. All damper operators must be able to close dampers against fan shut off pressure. Provide sufficient number of damper operators to achieve unrestricted movement throughout damper range. Provide one damper operator for maximum 36 sq ft of damper section.
- D. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
- E. Mounting: Actuators shall be capable of being mechanically and electrically paralleled to increase torque if required.
- F. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
- G. Fail-Safe Operation: Provide actuators with "normally open" or "normally closed" mechanical, spring-return positions as required by operation sequence or as required for freeze, fire, temperature, personnel, and/or equipment protection. Internal chemical storage systems, capacitors, or other internal non-mechanical forms of fail-safe operation are not acceptable.
 1. AHU outside air and relief air dampers shall fail closed.
 2. AHU return air dampers shall fail open.

- H. Power: Actuators shall be powered either by 24 or 120 VAC as required. All actuator power wiring shall be provided by Controls Contractor and coordinated with Electrical Contractor. Provide 3 ft. cable for connection to a junction box.
- I. Proportional actuators shall be fully-programmable. Control input, position feedback, and running time shall be factory or field programmable by use of external computer software. Diagnostic feedback shall provided indications of hunting or oscillation, mechanical overload, and mechanical travel.
- J. Temperature Rating: -22 to 122 Deg. F.
- K. Housing: Minimum NEMA Type 2 mounted in any orientation.
- L. A manual override shall be provided on the actuator body.
- M. The actuator must have the capability of adding an auxiliary switch or feedback potentiometer if required.
- N. Manufacturer shall warranty all actuators for a minimum of five years from the purchase date, with the first two years unconditional.

2.3 ACTUATORS FOR FIRE DAMPERS, SMOKE DAMPERS, AND FIRE/SMOKE DAMPERS

- A. Manufacturer: Belimo or equivalent.
- B. Size for torque required for damper seal at design load conditions. Exact size and type of actuators shall be determined from damper manufacturer's torque requirements, close-off ratings, system parameters, etc.
- C. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
- D. Overload Protection: Microprocessor or an electronic based motor controller providing burnout protection if stalled before full rotation is reached. The actuator shall be electronically cut off at full open to eliminate noise generation with the holding noise level to be inaudible.
- E. Power: Actuators shall be powered by 120 VAC. All actuator power wiring shall be provided by Controls Contractor and coordinated with Electrical Contractor. Provide 3 ft. cable for connection to a junction box.
- F. Temperature Rating: UL555S listing by damper manufacturer for 350 Deg. F.
- G. Actuator timing shall be 75 seconds or less to drive, or 20 seconds or less to spring per UL555S requirements..
- H. The actuator must have the capability of adding an auxiliary switch or feedback potentiometer if required.
- I. Manufacturer shall warranty all actuators for a minimum of five years from the purchase date, with the first two years unconditional.

2.4 ELECTRONIC SENSORS

A. WALL MOUNTED CARBON DIOXIDE SENSOR

1. Carbon dioxide sensor shall be wall mounted with non-dispersion-infrared technology for sampling, integrated temperature sensor. Measurement range shall be 0-3,000 ppm range with an accuracy of +/- 50 ppm or +/- 5% whichever is greater. 14°F to 140°F temperature range. LED display at sensor for status information. The annual sensor drift shall 20 ppm so that re-calibration is not required for five years. 0-10 VDC output to EMCS. Carbon dioxide sensor shall be Honeywell model C7242A or equivalent.

B. TEMPERATURE SENSORS: RTDs AND TRANSMITTERS

1. Room Thermostats: Temperature sensor shall have as minimum, integral linearized 20K ohm nickel thermistor, +/- 1°F accuracy from 45° to 95°F, setpoint adjustment with degrees F absolute (where applicable), occupied/unoccupied override and white case.
 - a. Setpoint adjustment shall only be provided in the following spaces:
 - 1) Offices, classrooms, and conference rooms throughout the facility.
 - b. Where setpoint adjustment is provided, it shall be limited to a range of +/- 5 deg F of the heating and cooling setpoints.
 - c. The room sensors for all other spaces shall not include setpoint adjustment capabilities.
2. Immersion and Airstream Temperature Sensors:
 - a. Resistance nickel temperature detectors with resistance tolerance of plus or minus 0.1 percent at 70 degrees F, interchangeability less than plus or minus 0.2 percent, time constant of 13 seconds maximum for fluids and 200 seconds maximum for air.
 - b. Measuring current maximum 5 mA with maximum self-heat of 0.031 degrees F/mW in fluids and 0.014 degrees F/mW in air.
 - c. Provide 3 lead wires and shield for input bridge circuit.
 - d. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements in larger ducts or as indicated or specified. Use sensor length of 8 feet or 16 feet as required.
 - e. Insertion elements for liquids shall be with brass socket with minimum insertion length of 2-1/2 inches. Provide extra brass socket directly adjacent to sensor socket for system calibration.
 - f. Outside air sensors: Watertight inlet fitting, shielded from direct rays of sun.
3. Electric, Low-Limit Duct Thermostats:
 - a. Snap-acting, single pole, single-throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal or below set point.
 - 1) Unless otherwise noted on drawings, initial setpoint shall be 35 deg F.
 - 2) Bulb Length: Minimum 20 feet.
 - 3) Quantity: One thermostat for every 20 sq. ft. of coil surface.
 - 4) Low-limit duct thermostats shall be Johnson Controls model A70HA-1 or approved equal.

C. PRESSURE TRANSMITTERS / TRANSDUCERS

1. Static Pressure Transmitters: Nondirectional sensor with suitable range for expected input (not exceeding 150 percent of maximum expected input), and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Building Static-Pressure Range: 0 to 0.25 inch w.g.
 - d. Duct Static-Pressure Range: 0 to 5-inch w.g.
 - 1) Verify that range is appropriate for anticipated static pressures when installed in Air-Handling Equipment.
2. Water Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig operating pressure; linear output 4 to 20 mA.
3. Water Differential-Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig operating pressure and tested to 300 psig; linear output 0 to 10 VDC proportional to differential pressure, compatible with the BAS.
 - a. Water: Units shall be wet/wet differential pressure capable of a bi-directional pressure range of +/- 50 psid. Accuracy shall be +/- 0.25% full scale with a compensated temperature range of 30 to 150 deg F and a maximum working pressure of 250 psig. Install transmitter in a pre-manufactured bypass valve assembly with shut-off valves, vent valves and a bypass valve, all enclosed in a NEMA 1 enclosure.
 - b. Setra model 230 with Kele model BVA-5 bypass valve assembly, or equivalent.
4. Differential Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
5. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA

2.5 STATUS SENSORS

- A. Status Inputs for Electric Motors: Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current, with LED indicator. Current sensors on motors equipped with VFDs must be capable of detecting status down to 6Hz. Units shall be powered by monitored line, UL listed and CE certified, and have a five year warranty. Provide multiple wraps of wiring on motors 1 hp or less in order to increase signal strength.

3. EXECUTION

3.1 INSTALLATION

- A. Control Wiring:
 1. Install electrical components and use electrical products complying with requirements of applicable Division-26 sections of these specifications. Mount equipment at convenient locations and heights. Do not mount any panels or other electronic equipment such that it is attached to vibrating equipment such as air handling units.
 2. The term "control wiring" is defined to include providing of wire, conduit and miscellaneous materials as required for mounting and connecting electric control devices.
 3. Install complete control wiring system for control systems. Coordinate with other trades such that control wiring, transformers, and all other required items are provided and installed for all required components.

4. All control wiring exposed or installed in mechanical rooms/penthouses shall be run in conduit. Provide flexible conduit at connections to actuators and other controlled devices.
 5. Concealed control wiring routed above acoustical ceiling is not required to be in conduit if allowed by code, but wire must be plenum rated. Clip wire to structural ceiling. All wiring to be run at right angles to building.
 6. Provide multi-conductor instrument harness (bundle) in place of single conductors where number of conductors can be run along common path. Fasten flexible conductors bridging cabinets and doors, neatly along hinge side, and protect against abrasion. Tie and support conductors neatly.
 7. Low voltage control wiring shall be run in separate conduit from line voltage power wiring.
 8. Number-code or color-code conductors, excluding those used for local individual room controls, appropriately for future identification and servicing of control system.
- B. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
 - C. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.
 - D. Ensure installation of components is complementary to installation of similar components.
 - E. Install in accordance with manufacturer's instructions.
 - F. All devices shall be mounted appropriately for the intended service and location.
 - G. Check and verify location of thermostats, humidity sensors and other exposed control sensors with plans and room details before installation. Locate 60 inches above floor on sensors without setpoint adjustment; locate at 48 inches above floor on sensors with setpoint adjustment. Align with lighting switches.
 - H. Mount outdoor sensors indoors, with sensing elements outdoors and sun shield.
 - I. Duct mounted sensors shall be provided with mounting brackets to accommodate insulation. Mounting clips for capillary tubes for averaging sensors are required.
 - J. Provide separable sockets for liquids and flanges for air bulb elements.
 - K. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.
 - L. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.
 - M. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.
 - N. Do not install controls components in areas below items which may potentially leak.

3.2 CALIBRATION AND RECALIBRATION

- A. Calibrate instruments.
- B. Make three-point calibration test for both linearity and accuracy for each analog instrument.
- C. Calibrate equipment and procedures using manufacturer's written recommendations and instructions manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
- D. Flow:
 - 1. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - 2. Manually operate flow switches to verify that they make or break contact.
- E. Pressure:
 - 1. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - 2. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- F. Temperature:
 - 1. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - 2. Calibrate temperature switches to make or break contacts.
- G. Stroke and adjust control dampers without positioners, following manufacturer's recommended procedure, so that damper is 100 percent open and closed.
- H. Stroke and adjust control dampers with positioners, following manufacturer's recommended procedure, so that damper is 100 percent open and closed.
- I. Provide diagnostic and test instruments for calibration and adjustment of system.
- J. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- K. At substantial completion, the contractor shall calibrate all humidity sensors according to the factory recommendations and demonstrate calibration of the sensor to the owner's representative. At the end of the one year warranty, the control contractor shall recalibrate all humidity sensors.

END OF SECTION

SECTION 23 09 93 - SEQUENCE OF OPERATION

1. GENERAL

- 1.1 The sequences provided in this section are subject to minor modifications during shop drawing review phase and system start-up. These minor changes are usually due to the specific operating characteristics of the HVAC equipment actually installed and/or building dynamics. These minor sequence modifications shall be incorporated without additional charges to the Owner.
- 1.2 All control set points called out shall be adjustable through software.
- 1.3 Refer to drawings for sequences of operation.

END OF SECTION

SECTION 23 21 13 - HVAC PIPING

1. GENERAL

1.1 SECTION INCLUDES

- A. Above grade pipe, fittings, and joints for :

- 1. Equipment drains and overflows.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. Quality assurance.

- B. References.

- C. Submittals.

- 1. Product Data: For each type of product.
 - 2. Pipe Schedule: Include pipe schedule that includes pipe system, pipe sizes, fittings, joints, and accessories.

- D. Operation and maintenance manuals.

- E. Project record documents.

- F. Delivery, storage, and handling.

1.3 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

- B. Use unions, flanges, and couplings downstream of equipment or apparatus connections. Do not use direct welded or threaded connections to equipment or other apparatus.

1.4 REGULATORY REQUIREMENTS

- A. Conform to International Mechanical Code for installation of piping system.

- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state and local labor regulations.

- C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.5 ENVIRONMENTAL REQUIREMENTS

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

1.6 EXTRA MATERIALS

- A. Provide two repacking kits for each size and valve type.

2. PRODUCTS

2.1 PVC PIPE, FITTINGS, AND JOINTS

- A. Applicable Systems
 - 1. Equipment drains and overflows
- B. Pipe: ASTM D1785, Schedule 80 or ASTM D2241, SDR 21 or 26 PVC
- C. Fittings: ASTM D2466 or ASTM D2467, PVC. All fittings shall meet or exceed pressure rating of piping.
- D. Joints: ASTM D2855, solvent weld.

3. EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.2 INSTALLATION

- A. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- B. Install piping to conserve building space and not interfere with use of space.
- C. Group piping whenever practical at common elevations.
- D. Slope piping and arrange to drain at low points.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Refer to Section 23 05 29 and Section 23 05 48 for installation of supports and hangers.

END OF SECTION

SECTION 23 31 13 - DUCTWORK

1. GENERAL

1.1 SECTION INCLUDES

A. Metal ductwork.

1. Sheet metal materials.
2. Sealant and gaskets.
3. Fasteners.
4. Seismic-restraint devices.
5. Duct cleaning.
6. Duct pressure testing.

B. Insulated flexible ductwork.

C. ~~Louver backpanes.~~

D. Related Requirements:

1. Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.
2. Section 23 05 93 "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing requirements for metal ducts.
3. Section 23 33 00 "Ductwork Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Submit detailed CAD-generated ductwork detail drawings at minimum 1/4" scale, with details of the following:
 - a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
 - 1) Elevation of top and bottom of ducts.
 - 2) Dimensions of main duct runs from building grid lines.
 - 3) Duct layout indicating pressure classification and sizes on plans.
 - 4) Penetrations through fire-rated and other partitions.
 - 5) Equipment installation based on equipment being used on Project.
 - 6) Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

- b. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
 - c. NOTE: No installation of ductwork shall be allowed until detailed shop drawings have been reviewed by the Engineer. Any ductwork that is installed prior to the Engineer's review of the shop drawings shall be subject to removal and replacement at the Contractor's expense.
 - 2. Submit ductwork schedule listing duct system, duct material, seam and joint construction, pressure class, sealant class, and leakage class.
 - 3. Factory- and shop-fabricated ducts and fittings.
 - 4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated Design Submittals:
- 1. Sheet metal thicknesses.
 - 2. Joint and seam construction and sealing.
 - 3. Reinforcement details and spacing.
 - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for duct joint and seam welding.

1.5 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct

Construction Standards - Metal and Flexible" and with performance requirements and design criteria indicated in "Duct Schedule" Article.

- B. Structural Performance: Duct hangers and supports and seismic restraints are to withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7.
- C. Seismically brace duct hangers and supports in accordance with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems.
- D. Seismic Performance: Ductwork to withstand the effects of earthquake motions determined in accordance with **ASCE/SEI 7**. See Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
 - 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. Component Importance Factor: **1.0**.
 - 3. Reference Structural Design Criteria in Structural Drawings.
- E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. References.
- B. Performance requirements.
- C. Project record documents.
 - 1. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
 - 2. Provide copy of owner approval/acceptance of ductwork cleaning.
 - 3. Provide copy of completed duct leakage test reports.
- D. Qualifications.
 - 1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
 - 2. Installer: Company specializing in performing the work of this section with minimum five years experience.

E. Regulatory requirements.

1. Construct all ductwork per codes listed in section 1.2.E

F. Environmental requirements.

1. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
2. Maintain temperatures during and after installation of duct sealants.

2. PRODUCTS

2.1 METAL DUCTWORK

A. SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
 - a. Reference SMACNA figure 2-9 and Drawings to construct gradual transitions where ductwork changes size or offsets.
 - b. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
2. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Duct Connection System
 - 1) Slide on flange system: Ductmate and Ductmate WDCI connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
 - 2) Formed on flange system: TDC, TDF or equivalent connection system or equivalent. Such flanges shall be constructed as SMACNA T-24 flange (Page 1-25 and 1-37 '85 SMACNA Duct Construction Manual, 1985 Edition).
3. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
4. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- a. Construct T's, and elbows in using radius of not less than 1-1/2 times width of duct on centerline. Where mitered rectangular elbows are used or indicated, provide turning vanes in accordance with Section 23 33 00.
5. Welded ductwork is to be weld with filler rod of the same material as the metal that is being welded. Coat welded joints with protective paint to prevent damage to galvanized surfaces.

B. SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

1. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - a. Round and oval duct shall be spiral lockseam duct with light reinforcing corrugations unless indicated otherwise.
2. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
3. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 - b. Joints shall be minimum 2 inch insertion length for joint connections.
 - c. Transverse Duct Connection System
 - 1) Slip type connector: Keating coupler.
 - 2) Slide on flange system. Spiralmate and Ovalmate connection system complete with interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.
 - 3) Formed on flange system: Factory-applied Van Stone connection on one end of the duct with field-applied Van Stone connector on the other end of the duct. Provide factory-applied Van Stone connections on each end of fittings.
4. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
5. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- a. Construct T's, bends, and elbows with minimum bend radius elbows shall be 1.5 times the duct diameter (major or minor axis on oval ductwork depending on direction of bend). Where not possible and where mitered elbows are used or indicated, provide turning vanes in accordance with Section 23 33 00.
6. Welded ductwork is to be weld with filler rod of the same material as the metal that is being welded. Coat welded joints with protective paint to prevent damage to galvanized surfaces.
7. On round and oval ducts, provide 45 deg wye tee take-offs or 90 deg conical tee take-offs or 45 degree low loss entry tee take-offs or other fitting as indicated on plans. Straight taps are not acceptable.

C. DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

1. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
2. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
 - a. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1) Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
 - b. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1) Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2) Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

- c. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
3. Inner Duct upstream of the VAV box: Solid wall pressure class to match outer wall.
4. Inner Duct Downstream of the VAV box: Minimum 24 gauge perforated galvanized sheet steel having 3/32-inch diameter perforations, with overall open area of 23 percent.
5. Interstitial Insulation Option A: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - a. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 - c. Coat insulation with antimicrobial coating.
 - d. Cover insulation with polyester film complying with UL 181, Class 1.²
6. Interstitial Insulation Option B: Poly Armor Polyester Duct Liner
 - a. Mildew and mold resistant: Does not promote or support the growth of mold or mildew.
 - b. Odor Characteristics: Pass ASTM C1304
 - c. Mold Growth Characteristics: Meets requirements of ASTM G-21
 - d. Fungi Resistance Characteristics: Meets requirements of ASTM C1338
 - e. Erosion Resistance Characteristics: Rating 4000 fpm
 - f. R- Value: R-4.2 @ 1", R-5 @ 1.25, R-6 @ 1.5", R-8 @ 2"
 - g. Maximum Service Temperature: 250 degrees F.
 - h. Maximum Moisture Absorption: ASTM C1104; 0.24 percent by volume.
 - i. Moisture Vapor Transmission: ASTM E96; 0.08 perm-inches.
 - j. Maximum Flame Spread: ASTM E84; <25.
 - k. Maximum Smoke Developed: ASTM E84; <50.
 - l. Connection: Waterproof vapor barrier adhesive.
 - m. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - n. Density: 1.5 lb/cu. ft. @ 1.25" 1.4 lb/cu.ft @ 2"
 - o. Sound Absorption at 1" thickness: ASTM C423 and ASTM E795
 - 1) 125 Hz: 0.10
 - 2) 250 Hz: 0.30
 - 3) 500 Hz: 0.73
 - 4) 1 kHz: 1.07
 - 5) 2 kHz: 0.49
 - 6) NRC: 0.65

D. SHEET METAL MATERIALS

1. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2. Galvanized Steel Ducts: ASTM A653 galvanized steel sheet, lock-forming quality, having G90 zinc coating of in conformance with ASTM A90. Provide mill-phosphatized finish for surfaces of ducts exposed to view.
3. Stainless Steel Ducts: ASTM A 480/A 480M, Type 316 sheet form with No. 4 finish for surfaces of ducts exposed to view, and Type 304 sheet form with No. 1 finish for concealed ducts.
4. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
5. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

E. DUCT LINER

1. See 23 07 13 Ductwork Insulation specification.

F. SEALANT AND GASKETS

1. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
2. Two-Part Tape Sealing System:
 - a. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - b. Tape Width: Min. 3 inches.
 - c. Sealant: Modified styrene acrylic.
 - d. Water resistant.
 - e. Mold and mildew resistant.
 - f. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - g. Service: Indoor and outdoor.
 - h. Service Temperature: Minus 40 to plus 200 deg F.
 - i. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - j. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Water-Based Joint and Seam Sealant:
 - a. Application Method: Brush on.
 - b. Solids Content: Minimum 65 percent.
 - c. Shore A Hardness: Minimum 20.
 - d. Water resistant.
 - e. Mold and mildew resistant.
 - f. VOC: Maximum 75 g/L (less water).
 - g. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - h. Service: Indoor or outdoor.
 - i. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
4. Flanged Joint Sealant: Comply with ASTM C 920.
 - a. General: Single-component, acid-curing, silicone, elastomeric.

- b. Type: S.
 - c. Grade: NS.
 - d. Class: 25.
 - e. Use: O.
 - f. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 5. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
 - 6. Round Duct Joint O-Ring Seals:
 - a. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - b. Retain one or both subparagraphs below. These are proprietary seals provided on factory-fabricated, round duct fitting joints and constructed with specific dimensions to ensure a proper seal.
 - c. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - d. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

G. FASTENERS

- 1. Rivets, bolts, or sheet metal screws.

H. SEISMIC-RESTRAINT DEVICES

- 1. Refer to Specification Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, Fire Suppression and Electrical Building Systems" for seismic restraint devices and installation.

2.2 INSULATED FLEXIBLE DUCTS

- A. UL 181, Class 1, mechanically-locked spun nylon fabric supported by helically wound spring steel wire; fiberglass insulation; fire retardant polyethylene vapor barrier film.
- B. Pressure Rating: 6 inches WG positive, 5.0 inches WG negative (through 16" diameter), 1.0' WG negative (18" to 20").
- C. Maximum Velocity: 5500 fpm.
- D. Temperature Range: -20 degrees F to 250 degrees F.
- E. Minimum Sound Attenuation Performance (Insertion Loss in dB of 12' Length of 12" Round Duct):
 - 1. 63 Hz Octave Band: 13
 - 2. 125 Hz Octave Band: 37
 - 3. 250 Hz Octave Band: 31
 - 4. 500 Hz Octave Band: 34
 - 5. 1 kHz Octave Band: 37
 - 6. 2 kHz Octave Band: 47
 - 7. 4 kHz Octave Band: 34

- F. Manufacturer: Flexmaster Type 6B or equivalent.

3. EXECUTION

3.1 GENERAL

- A. Install in accordance with manufacturer's instructions; SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition and International Mechanical Code requirements.
- B. Seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, current edition.
- C. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Duct transition from round to rectangular and vice versa shall be made with rectangular to round duct transition fitting.
- E. Provide flange-type joint at transverse joints or seal as specified. All transverse joints shall be inspected by the Owner prior to insulating ductwork.

3.2 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install round and flat-oval ducts in maximum practical lengths.
 - a. Install round in lengths not less than 12 feet, unless interrupted by fittings.
- C. Install ducts with fewest possible joints.
- D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- G. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- H. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- I. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
 - 1. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Keep openings covered until ready for continuing duct run or final connections.
- J. Construct and install each duct system for the specific duct pressure classification indicated.
- K. Install only low loss high efficiency fittings at takeoffs. Extractors not allowed.
 - 1. Air terminal take-offs from rectangular main ducts shall be lo-loss 45° take-offs.
 - 2. Diffusers and register take-offs from rectangular duct mains shall be lo-loss 45° fittings, with integral balancing damper that is provided with stand-off bracket and quadrant lock.
 - 3. Exhaust grille/register branch duct connections to rectangular mains shall be lo-loss 45° entry fittings with integral balancing damper.
- L. Install couplings tight to duct wall surface with a minimum of projections into duct.
- M. Install ducts with a clearance of 2 inch, plus allowance for insulation thickness.
- N. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
- O. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 07 Section "Firestopping."
 - 1. Refer to drawings for more information.
- P. Verify location of air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement. Refer to reflected ceiling plans, finish schedule, material finish specification, and shop drawings.
- Q. Coordinate routing with all other trades to establish space requirements for each.
- R. Contractor may vary route and shape of ductwork and make offsets during progress of work if required to meet structural or other interferences. Where such changes impair the system performance, the changes will be corrected at Contractor's expense.
- S. All ductwork shall be substantially and neatly supported on galvanized steel straps or angles riveted or bolted to duct flanges and properly anchored to the construction so that horizontal ducts are without sag or sway, vertical ducts are without buckle, and all ducts are free from the possibility of deformation, collapse or vibration. Support at each joint and at 4 feet on center maximum.
- T. Openings required for ductwork through structural elements in new construction shall be coordinated with the General Contractor. Shop drawings locating such openings shall be prepared in ample time to meet the construction schedule.

- U. Provide sleeves at all duct penetrations through walls, floors and roofs. Openings through sound-rated partitions shall have annular space stuffed with fiberglass insulation for full thickness of wall.
- V. Provide 2-inch deep bitumastic coated drip pans on all non-ducted hoods, fans or penthouses used for relief or exhaust air service. Pans shall be 12 inches larger all around than roof opening with clear vertical openings between pan and structure as indicated. Insulate pan where indicated.
- W. Where required on drawings, install automatic control dampers as recommended by the manufacturer.
- X. Prevent passage of unfiltered air around filters with felt, rubber, neoprene gaskets, or other approved safing material.
- Y. Provide openings in ductwork to accommodate thermometers and controllers. Provide pitot tube openings for testing of systems, complete with metal cap with spring device or screw to prevent air leakage.
- Z. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- AA. Paint ductwork visible behind wall-mounted air outlets and inlets matte black.
 - 1. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer.
- BB. Change duct sizes gradually, not exceeding 30 degrees (15 degrees ideally) divergence and 45 degrees (30 degrees ideally) convergence.
- CC. Use crimp joints with or without bead for joining round duct sizes 8 inches and smaller and install with crimp in direction of air flow.
- DD. Provide return air grilles open to ceiling plenum with duct boot with minimum longitudinal dimension 2' X 2'.
- EE. Provide flexible connect between ductwork and all moving equipment.
 - 1. Provide 1-inch slack for free movement.
- FF. Join VAV boxes to medium pressure supply duct mains with minimum straight length of duct equal to 5 times box inlet diameter size. Duct to be rigid. Flexible ductwork is not allowed to join boxes to supply duct main.
- GG. Threaded cap test holes shall be provided in all ductwork. Test holes shall be installed after the reheat coil in all VAV boxes. Provide extensions to allow for insulation thickness. Test holes shall be "Ventlok" or equal.
- HH. Connect flexible ducts to metal ducts with stainless steel bands with worm gear tightener, nylon bands are unacceptable.

1. Connection to metal ducts shall be in accordance with installation requirements outlined in the Air Diffusion Council's Flexible Duct Performance & Installation Standards, Current Edition. Worm gear tightener shall be used to secure flexible duct core to metal duct. Jacket and insulation shall be pulled back over inner core and taped with minimum 2 wraps of tape.
 - II. Unless otherwise noted, provide maximum of 6' of flexible duct upstream of each diffuser or grille. See details on Drawings.
 - JJ. Cover all exposed fiberglass insulation with duct tape.
- 3.3 INSTALLATION OF EXPOSED DUCTWORK
- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
 - B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
 - C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
 - D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
 - E. Repair or replace damaged sections and finished work that does not comply with these requirements.
 - F. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.
 - G. Provide closure flanges around exposed ductwork at wall and ceiling penetrations, 1-1/4 inches wide minimum.
- 3.4 INSTALLATION OF 2" AND GREATER PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)
- A. All round and oval duct elbows installed shall be die-formed, gored, pleated or mitered.
 - B. All mitered elbows shall be equipped with turning vanes.**
 - C. On round and oval ducts, provide 45 deg wye or 90 deg conical tee take-offs as indicated on plans. Straight taps are not acceptable.
 - D. All diverging flow fittings shall be constructed such that no excess material projects from the body into the branch tap entrance.
 - E. Transverse joints of all rectangular ducts greater than 24" wide or deep shall be fabricated with flanging system as called out previously (Ductmate or equivalent).

3.5 INSTALLATION OF 1" AND LESS PRESSURE CLASS DUCTWORK (POSITIVE OR NEGATIVE PRESSURE)

- A. All round duct elbows installed shall be of the adjustable, die-formed, gored, pleated or mitered type. All adjustable elbows shall be sealed after installation.
- B. All mitered elbows shall be equipped with turning vanes.**
- C. Connect ceiling diffusers to low pressure ducts with adjustable elbow at duct and short length of flexible duct held in place with strap or clamp. Do not use flexible duct to change direction. Connection detail as well as maximum length of flex duct allowed to diffusers is indicated on the plans.

3.6 CLEANING

- A. **The rooftop unit, exhaust fans, and other HVAC airside equipment shall not be used for temporary building conditioning without the written permission from the Owner and Architect/Engineer.** Open ductwork that has been installed shall be protected during the duration of the project with polyethylene plastic and duct tape over the open ends. Uninstalled ductwork shall be protected from construction dust by covering the uninstalled ductwork with polyethylene plastic. Prior to installing ductwork, the inside of the ductwork shall be wiped down or vacuumed.
- B. Clean inside all rooftop units before the fans are turned on. Call for inspection by the owner's representative to verify that all ducts are cleaned. If the ductwork is unacceptable, the contractor shall provide vacuuming of these duct systems by forcing air at high velocity through duct where manual cleaning is not possible due to duct lengths or size. Call for re-inspection by Owner's representative.
- C. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.
- D. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
- E. Use service openings, as required, for physical and mechanical entry and for inspection.
- F. Call for inspection by Owner's representative and provide documentation of owner approval to engineer and include copy in maintenance manuals.
- G. Install a fresh set of filters in all equipment immediately prior to project turnover.

3.7 DUCTWORK SCHEDULE

Duct System:	Material:	Longitudinal Joints:	Transverse Joints:	Pressure Class:	Sealant Class:	Leakage Class:	Additional Notes:
Rectangular SA system upstream of terminal units	Galv. Steel	3A, 3E	4A, 4C, 4D	+4"	A	6	8B
Round SA system upstream of terminal units	Galv. Steel	3C, 3E	4B, 4D	+4"	A	3	8B
Rectangular SA system downstream of terminal units	Galv. Steel	3A, 3B, 3E	4A, 4C, 4D	+2"	A	24	8B
Round SA system downstream of terminal units	Galv. Steel	3C, 3E	4B, 4D	+2"	A	12	8B
Rectangular general EA or RA system	Galv. Steel	3A, 3B, 3E	4A, 4C, 4D	-2"	A	24	8B
Round general EA or RA system	Galv. Steel	3C, 3E	4B, 4D	-2"	A	12	8B, 8C

DUCTWORK SCHEDULE NOTES:

Longitudinal Joint Options:

- 3A: Pittsburgh lock. Refer to Figure 1-5, SMACNA.
3B: Button punch snap lock. Refer to Figure 1-5, SMACNA.
3C: Spiral lockseam.
3E: Welded.
3F: Double-wall, pre-manufactured sheet metal plenum.
3G: Butt-welded, fully-welded around entire perimeter of joint from outside in accordance with IMC.

Transverse Joint Options:

- 4A: Pre-manufactured flanged duct connection system specified under "Products" section of this specification.
4B 0-24" Major Axis Diameter: Interior slip coupling beaded at center, fastened to duct with sealing compound applied continuously around joint before assembling and after fastening.
26" Major Axis Diameter and Up: Pre-manufactured flanged duct connection system specified under "Products" section of this specification.
4C: Any standard transverse joint as shown in Figure 1-4 of SMACNA is acceptable.
4D: Welded
4E: Fully-welded at all joints from outside in accordance with IMC.

Sealant Class Options:

- 6: Seal class is defined by the following table (refer to Table 4-1, SMACNA HVAC Air Duct Leakage Test Manual):

Seal Class:	Sealing Required:
A	All transverse joints, longitudinal seams, and ductwork penetrations. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.
B	All transverse and longitudinal seams. Pressure sensitive tape shall not be used as a primary sealant on metal ducts.
C	Transverse joints only.

Leakage:

- 7: Leakage Class is defined by Figure 4-1, SMACNA HVAC Air Duct Leakage Test Manual.

Additional Comments:

- 8A: See Drawings for further information regarding extent of stainless steel ductwork.
- 8B: Field welded ductwork is to be welded with filler rod of the same material as the metal that is being welded. Field coat welded joints with protective paint to prevent damage to galvanized surfaces.

8C: Regardless if allowable by SMACNA, Snaplock longitudinal joints shall not be used for round ductwork.

3.8 PRESSURE TESTING

- A. Perform and complete the following field tests, inspections, and test reports according to SMACNA's "HVAC Air Duct Leakage Test Manual":
1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 3. Maximum Allowable Leakage: Refer to paragraph 3.7.
 4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.
 5. Test no less than
 - a. 25% of the supply air ductwork upstream of terminal units
 6. Submit completed test reports to engineer and include copy in maintenance manual.

END OF SECTION

SECTION 23 33 00 - DUCTWORK ACCESSORIES

1. GENERAL

1.1 SECTION INCLUDES

- A. Turning vanes.
- B. Duct access doors.
- C. Duct test holes.
- D. Flexible duct connections.
- E. Smoke dampers.
- F. Combination fire and smoke dampers.
- G. Manual balancing dampers.
- H. Gravity backdraft dampers.
- I. Remote damper operators

1.2 ACTION SUBMITTALS

- A. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Retain subparagraph below if equipment includes wiring.
 - g. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fusible Links: Furnish quantity equal to **[10]** percent of amount installed with a minimum of a (2) links being provided.

1.5 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

1.6 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. References.
- B. Project record documents.
 - 1. Record actual locations of access doors, test holes etc.
- C. Qualifications.
 - 1. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience.
- D. Regulatory requirements.
 - 1. Products Requiring Electrical Connection: UL Listed and classified.
- E. Delivery, storage, and handling.
- F. Extra materials.
 - 1. Provide two of each size and type of fusible link for fire and combination fire/smoke dampers.

2. PRODUCTS

2.1 TURNING VANES

- A. General:
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
 - 2. Note that air extractors or "scoops" shall not be used under any circumstances.

- B. Manufactured and Fabricated Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
 - 2. Single-Thickness Vane Construction: Vanes shall be single-thickness, quarter-circle shape with 2" radius, minimum 3.15" length, and spaced 1.5" on center.
 - 3. Double-Thickness Vane Construction: Vanes shall be double-thickness, quarter-circle shape, with 4.5" radius and spaced 3.25" on center.
 - 4. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.2 DUCT ACCESS DOORS

- A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Double wall, rectangular door.
 - 2. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - 3. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches.
 - d. Access Doors Larger Than 24 by 48 Inches : Four hinges and two compression latches with outside and inside handles.
 - e. Fabricate doors airtight and suitable for duct pressure class.
 - 4. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

2.3 DUCT TEST HOLES

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

2.4 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches to 5-3/4 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel or 0.032-inch thick aluminum sheets. Provide metal compatible with connected ducts.

1. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - a. Minimum Weight: 26 oz./sq. yd.
 - b. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - c. Service Temperature: Minus 40 to plus 200 deg F.
2. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - a. Minimum Weight: 24 oz./sq. yd.
 - b. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - c. Service Temperature: Minus 50 to plus 250 deg F.
3. Fan Discharge Flexible Connectors: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - a. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - b. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - c. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - f. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 - g. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.5 SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A and UL 5555, and as indicated.
- B. Smoke Detector: Refer to electrical drawings and Division 28 for additional information.
- C. Dampers: UL Class 1 multiple blade type damper, automatically operated by electric actuator.
- D. Provide with remote switch pack that provides the ability to remotely indicate blade position.
 1. Ruskin SP100 or equal.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

- A. Fabricate in accordance with NFPA 90A, UL 555, UL 555S, and as indicated.
- B. Provide factory sleeve and collar for each damper.
- C. Smoke Detector: Refer to electrical drawings and Division 28 for additional information.

- D. Multiple Blade Dampers: Fabricate with 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, stainless steel jamb seals, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock, and 1/2 inch actuator shaft.
- E. Operators: UL listed and labeled spring return electric type suitable for 120 volts, single phase, 60 Hz. Locate damper operator on exterior of duct and link to damper operating shaft.
- F. Normally Open Smoke Responsive Fire Dampers: Curtain type, closing upon actuation of electro thermal link, flexible stainless steel blade edge seals to provide constant sealing pressure, stainless steel springs with locking devices to ensure positive closure for units mounted horizontally.
- G. Electro Thermal Link: Fusible link melting at 165 degrees F; 120 volts, single phase, 60 Hz; UL listed and labeled.
- H. Provide with remote switch pack that provides the ability to remotely indicate blade position.
 - 1. Ruskin SP100 or equal.

2.7 MANUAL BALANCING DAMPERS

- A. General:
 - 1. Suitable for horizontal or vertical applications.
 - 2. Fabricated in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
 - 3. Dampers shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 4. **Provide 304 stainless steel construction when installed in stainless steel duct systems.**
- B. Single Blade Dampers:
 - 1. Ruskin models MD25 (rectangular), MDRS25 (round) or equivalent.
 - 2. Fabricate for duct sizes up to 6 x 30 inch.
 - 3. Frame: 20 gauge galvanized steel, 6" wide.
 - 4. Blade: 20 gauge galvanized steel.
 - 5. Control shaft / hand quadrant: 3/8" square axle shaft extending beyond frame through factory mounted, locking hand quadrant.
 - a. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulator shall be equivalent to Sheet Metal Connectors Model RP-3, with heavy-gauge steel regulator, wing nut locking assembly, and stamped dial indicating damper position.
 - b. On externally insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters to avoid damaging or compression of insulation.
 - 6. Bearings: Molded synthetic.
 - 7. Finish: Mill galvanized.
 - 8. Maximum velocity: 1500 fpm.

9. Maximum temperature: 250 deg F.

C. Multi-Blade Damper:

1. Ruskin model MD35 or equivalent.
2. Frame: 5" x 1" x 16 gauge galvanized steel channel with corner braces. Low profile top and bottom 3-1/2" x 3/8" x 16 gauge galvanized steel channel 13" high and under, actual.
3. Blade: 8" maximum width 16 gauge galvanized steel, opposed blade.
4. Blade stop: 20 gauge galvanized steel.
5. Finish: Mill galvanized.
6. Linkage: Exposed or concealed as recommended by manufacturer.
7. Axles: 1/2" hex.
8. Bearings: Molded synthetic.
9. Control shaft: 3" x 3/8" square plated steel, 1/2" dia. Jackshaft for multisection dampers.

- a. Jackshaft to operate multi-section damper from one side.

10. Temperature limits: -40 deg F min. to 240 deg F max.
11. Quadrants:

- a. Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulator shall be equivalent to Sheet Metal Connectors Model RP-3, with heavy-gauge steel regulator, wing nut locking assembly, and stamped dial indicating damper position.
- b. On externally insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters to avoid damaging or compression of insulation.
- c. Where rod lengths exceed 30 inches, provide regulator at both ends.

2.8 TAKEOFFS

- A. Manufactured high-efficiency takeoff with 45-degree slope on the body, with gauge thickness equal to adjacent ductwork.
 1. Damper may be provided with high-efficiency takeoff pending conformance with product requirements for manual balancing dampers.

2.9 CABLE REMOTE DAMPER OPERATORS

- A. Manufacturer: United Enertech Corporation or equivalent, model BO-RI (Round) and BO-100 (Rectangular).
- B. BO-RI Construction:
 1. Frame: 24 ga galv. steel (4"-10" diam.), 20 ga galv steel (12"-20" diam.)
 2. Blade: 24 ga galv. steel (4"-10" diam.), 20 ga galv steel (12"-20" diam.)
 3. Bearings: Nylon 6/6 molded synthetic
 4. Axles: Zinc plated steel pins
 5. Bowden Control Wire: 303 stainless steel
 6. Remote operator: BO-300

- C. BO-100 Construction:

1. Frame: 0.081" extruded aluminum
2. Blade: 0.125" extruded aluminum
3. Bearings: Bronze Olite
4. Axles: ½" zinc plated steel with thrust bearing (no jamb seals)
5. Side plate: 18 ga galv. steel
6. Bowden Control Wire: 303 stainless steel
7. Remote operator: BO-300

3. EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 13 for duct construction and pressure class.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts and stainless-steel accessories in stainless-steel ducts.
- C. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 1. On both sides of duct coils.
 2. Upstream from duct filters.
 3. At outdoor-air intakes and mixed-air plenums.
 4. At drain pans and seals.
 5. Downstream from control dampers, backdraft dampers, and equipment.
 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 7. Upstream or downstream from duct silencers.
 8. Control devices requiring inspection.
 9. Elsewhere as indicated.
- D. Unless duct access door size is explicitly indicated, provide minimum 24 x 18 inch size duct access doors wherever possible. Provide 18 x 18, 12 x 12 inch or 8 x 8 inch size elsewhere, using the largest size possible.
- E. Install access doors with swing against duct static pressure.
- F. Provide duct test holes where indicated and required for testing and balancing purposes. Install with minimum 24" clear dimension from any side wall or other obstruction.

- G. Provide fire dampers, combination fire and smoke dampers and smoke dampers at locations indicated and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- H. Coordinate installation of all fire dampers, combination fire and smoke dampers, and smoke dampers with all other disciplines to ensure a minimum of 24 x 24 inch clear horizontal access area from the ceiling vertically to the damper. The clear access area will be used for the inspection of damper fusible links and damper operators, as well as for the resetting of damper. Clear access areas and appropriate wall/ceiling access panels, if required, shall be clearly shown on the coordination drawings.
- I. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
- J. All fire and combination fire/smoke dampers shall be commissioned (tested) in the presence of Owner representative following installation and before the corresponding fan systems are turned on. Contractor shall open all access doors for the inspection and close all doors in the presence of the inspector.
- K. Demonstrate re-setting of fire dampers to Owner's representative.
- L. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and supported by vibration isolators. Install flexible connectors with adequate flexibility to allow for all thermal, axial, transverse and torsional movement. Provide airtight seal.
- M. Provide balancing dampers at points on supply, return, and exhaust systems where indicated on plans.
- N. Set dampers to fully open position before testing, adjusting, and balancing.
- O. Provide a high-efficiency takeoff with 45-degree entry for each branch connection.
- P. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
- Q. The use of splitter dampers is not acceptable.
- R. Install remote damper actuators where the balance damper is not accessible. Field paint the remote actuator cap to match the adjacent ceiling finish.
 - 1. In these areas, the contractor shall provide and install damper in ductwork and shall connect damper to terminal point in ceiling with Bowden control wire.
 - 2. Install per manufacturer instructions.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:

- 1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 34 23 - POWER VENTILATORS

1. GENERAL

1.1 SECTION INCLUDES

- A. Centrifugal roof exhaust fans.

1.2 REFERENCES

- A. Air Movement and Control Association Inc. (AMCA):

- 1. 99 - Standards Handbook
- 2. 200 - Publication, Air Systems
- 3. 201-90 - Publication, Fans and Systems
- 4. 202-88 - Publication, Troubleshooting
- 5. 203-90 - Publication, Field Performance Measurement of Fan Systems
- 6. 211-05 - Publication, Certified Ratings Program – Product Rating Manual for Fan Air Performance
- 7. 300-96 - Standard Reverberant Room Method for Sound Testing of Fans
- 8. 311-05 - Publication Certified Ratings Program – Product Rating Manual for Fan Sound Performance
- 9. 99-0401-86 - Classification for Spark Resistant Construction
- 10. 99-2408-69 - Operating Limits for Centrifugal Fans

- B. Air Movement and Control Association Inc. (AMCA), American National Standards Institute (ANSI):

- 1. 204-05 - Standard Balance Quality and Vibration Levels for Fans
- 2. 210-99 - Standard Laboratory Methods of Testing Fans for Aerodynamic Performance Rating

- C. American National Standards Institute (ANSI):

- 1. 11-r1999 - Method of Evaluating Load Ratings of Bearings

- D. American Society of Civil Engineers (ASCE):

- 1. 7-02 - Minimum Design Loads for Building and Other Structures

- E. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE):

- 1. Chapter 45 - 2003 handbook, HVAC Applications
- 2. Chapter 7 - 2001 Fundamentals handbook, Sound-Vibration
- 3. Chapter 32 - 2001 Fundamentals handbook, Duct Design
- 4. Chapter 18 - 1992 HVAC System and Equipment handbook, Fans

- F. American Society for Testing and Materials (ASTM):

1. E330-02 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylight and Curtain Walls by Uniform Static Air Pressure Difference

G. National Fire Protection Association (NFPA)

1. 70 - National Electrical Code
2. 90A-02 - Standard for the Installation of Air-Conditioning and Ventilating Systems
3. 92A-06 - Recommend Practice for Smoke-Control System
4. 92B-05 - Standard for Smoke Management System in Malls, Atria, and Large Areas
5. 96-04 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations

H. Occupational Safety and Health Administration (OSHA):

1. 1910.212 - General requirements for Machine Guarding
2. 1910.219 - General requirements for guarding safe use of mechanical power transmission apparatus
3. 1926.300 - General requirements for safe operation and maintenance of hand and power tools

I. Underwriters Laboratories (UL):

1. 507 - Electric Fans
2. 555 - Fire Dampers
3. 555S - Smoke Dampers
4. 705 - Standard Power Ventilators
5. 705 – Supplement SC - Standard Power Roof Ventilators for Restaurant Exhaust Appliances
6. 793 - Snow Load

1.3 QUALITY ASSURANCE

- A. Performance ratings: Conform to AMCA standard 211 and 311. Fans must be tested in accordance with ANSI/AMCA Standard 210-99 and AMCA Standard 300-96 in an AMCA accredited laboratory. Fans shall be certified to bear the AMCA label for sound and air performance seal.
- B. Classification for Spark Resistant Construction shall conform to the intent of ANSI/AMCA Standard 99.
- C. Each fan shall be given a balancing analysis which is applied to wheels at the outside radius. The maximum allowable static and dynamic imbalance is 0.05 ounces (Balance grade of G6.3).
- D. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.
- E. The High Wind models have been analyzed and stamped by a state license P.E. to the ASCE 7-02 Standard which meets the IBC, Florida and Miami-Dade codes.
- F. Each High Wind model is subject to be certified by a third party to the ASTM E330 Static Pressure Difference Standard.

- G. All High Wind models have been analyzed using Computational Fluid Dynamics (CFD). The CFD simulates the flow of high speed (150MPH) winds over the surface of objects.
- H. The Finite Element Analysis (FEA) is the results from the CFD and it can accurately predict the stress, strain, and deflection resulting from high wind loads.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
- B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.
- C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer

1.5 WARRANTY

- A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
 - 1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the purchase date. Any units or parts which prove defective during the warranty period will be replaced at the Manufacturers option when returned to Manufacturer, transportation prepaid.
 - 2. Motor Warranty is warranted by the motor manufacturer for a period of one year. Should motors furnished by us prove defective during this period, they should be returned to the nearest authorized motor service station.

1.6 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product.
 - a. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - b. Rated capacities, furnished specialties, and accessories for each fan.
 - c. Fans:
 - 1) Certified fan performance curves with system operating conditions indicated.
 - 2) Certified fan sound-power ratings.
 - 3) Fan construction and accessories.
 - 4) Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 5) Fan speed controllers.

- d. Material thickness and finishes, including color charts.
- e. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

- 1. Include plans, elevations, sections, and attachment details.
- 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 3. Include diagrams for power, signal, and control wiring.
- 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
- 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated Design Submittal: For vibration isolation, supports, and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- 1. Design Calculations: Calculate requirements for selecting vibration isolators, supports, seismic restraints, and for designing vibration isolation bases.

1.7 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Data: Certificates, for fans, 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. Startup service reports.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fans and ventilators, include the following:

- 1. Operation and maintenance manuals.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective coverage for storage and identified with labels describing contents.

- 1. Belts: **[One]** set for each belt-driven unit.

1.10 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.
- C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of unit components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- F. Seismic Performance: Fans and ventilators are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
 - 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. Component Importance Factor: 1.0.

2. PRODUCTS

2.1 CENTRIFUGAL ROOF EXHAUST FANS

- A. Manufacturer
 - 1. Greenheck or equivalent.
- B. General Description
 - 1. Downblast fan shall be for roof mounted applications
 - 2. Maximum continuous operating temperature is 180 Fahrenheit (82.2 Celsius)
 - 3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number.
- C. Wheel

1. Constructed of aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

D. Motors

1. Electronically Commutated Motor
 - a. Motor enclosures: Open type
 - b. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
 - c. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
 - d. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
 - e. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
 - f. Motor shall be a minimum of 85% efficient at all speeds.

E. Housing

1. Motor cover, shroud, curb cap, and lower windband shall be constructed of heavy gauge aluminum
2. Shroud shall have an integral rolled bead for extra strength
3. Shroud shall be drawn from a disc and direct air downward
4. Lower windband shall have a formed edge for added strength
5. Motor cover shall be drawn from a disc
6. All housing components shall have final thicknesses equal to or greater than preformed thickness.
7. Curb cap shall have pre-punched mounting holes to ensure correct attachment
8. Rigid internal support structure
9. Leak proof

F. Housing Supports and Drive Frame:

1. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators

G. Vibration Isolation:

1. Rubber isolators
2. Sized to match the weight of each fan

H. Disconnect Switches

1. NEMA rated: 3R
2. Positive electrical shut-off
3. Wired from fan motor to junction box installed within motor compartment

I. Options/Accessories:

1. Birdscreen:
 - a. Material Type: Aluminum
 - b. Protects fan discharge
2. Roof Curbs:
 - a. Types: GPI
 - b. Mounted onto roof with fan
 - c. Material: Aluminum
 - d. Insulation thickness: 1.5 inches
 - e. Flashing Flange: 5 inch
 - f. Coating Type: None
3. Curb Extension:
 - a. Type: GPE
 - b. Material Type: Aluminum
 - c. Coating: None
4. Curb Seal:
 - a. Rubber seal between the fan and the roof curb
5. Dampers:
 - a. Type: Gravity
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with prepunched mounting holes
6. Hinge Kit:
 - a. Aluminum hinges
 - b. Allows the fan to tilt away for access to wheel and ductwork for inspection and cleaning
7. Variable Frequency Drive
 - a. Factory programed, mounted and wired
 - b. Input speed control 0-10VDC
 - c. 24VDC control power output
 - d. Motor: (VFD Rated) compatible with induction and permanent magnet motors
 - e. Parameters of acquainted motor shall be set to include voltage, speed, FLA, acceleration/deceleration time, and minimum & maximum motor frequency
 - f. R³ Filtering for harmonic mitigation
 - g. NEMA 4X Enclosure
 - h. LED indication for Power, Run, and Fault

3. EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's product data, including technical bulletins, product catalog installation instructions

3.2 EXAMINATION

- A. Examine areas to receive fans. Notify the Engineer of conditions that would adversely affect installation or subsequent utilization and maintenance of fans. Do not proceed with installation until unsatisfactory conditions are corrected

3.3 PREPARATION

- A. Ensure roof openings are square, accurately aligned, correctly located, and in tolerance
- B. Ensure duct is plumb, sized correctly, and to proper elevation above roof deck. Install duct as specified in Air Distribution (Division 23)

3.4 INSTALLATION

- A. Install fans system as indicated on the Installation, Operation and Maintenance Manual (IOM) and contract drawings
- B. Install fans in accordance with manufacturer's instructions

3.5 SYSTEM STARTUP

- A. Refer to Installation, Operation, and Maintenance Manual (IOM)

3.6 ADJUSTING

- A. Adjust exhaust fans to function properly
- B. Adjust Belt Tension
- C. Lubricate bearings
- D. Adjust drive for final system balancing
- E. Check wheel overlap

3.7 CLEANING

- A. Clean as recommended by manufacturer. Do not use material or methods which may damage finish surface or surrounding construction

3.8 PROTECTION

- A. Protect installed product and finished surfaces from damage during construction
- B. Protect installed exhaust fans to ensure that, except for normal weathering, fans will be without damage or deterioration at time of substantial completion

END OF SECTION

SECTION 23 36 00 - AIR TERMINAL UNITS

1. GENERAL

1.1 SECTION INCLUDES

- A. Variable volume terminal units.
- B. Integral wiring and controls.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
 - 1. Include plans, elevations, sections, and mounting details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
 - 4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
- C. Delegated Design Submittal: For vibration isolation and supports, and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Materials, fabrication, assembly, and spacing of hangers and supports.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators, supports, and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: For air terminal units, 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. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. Instructions for resetting minimum and maximum air volumes.
 - b. Instructions for adjusting software set points.

1.5 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.
- B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, supports, and seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- E. Seismic Performance: Air terminal units shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
 - 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. Component Importance Factor: 1.0.
 - 3. Component Amplification Factor: 2.5
 - 4. Component Response Modification Factor: 6.0

2. PRODUCTS

2.1 SINGLE DUCT VARIABLE VOLUME UNITS

- A. See Drawings for further information.
- B. Basic Assembly:
 - 1. Casings: Minimum 22 galvanized steel.
 - 2. Liner: Fiber-free internal liner.
 - 3. Air Outlets: S slip and drive connections.
- C. Basic Unit:

1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
2. Volume Damper: Construct of steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 4 percent of design air flow at three (3) inches inlet static pressure.
3. Mount damper operator to position damper normally open or normally closed as required by the operation sequence.
4. On units with heating coils, provide minimum 9"x6" hinged and gasketed access door on bottom of unit to facilitate coil inspection.

D. Velocity Sensors: Removable multipoint array at air inlet.

E. Electric Heating Coil:

1. Construction: UL listed, slip-in type, open coil design, integral control box factory wired and installed, with:
 - a. Primary and secondary over-temperature protection.
 - b. Minimum airflow switch.
 - c. Electric switches and relays.
2. Electrical Characteristics: As scheduled.

2.2 WIRING

1. Factory-mount and wire controls. Mount electrical components in control box with removable cover. Incorporate single point electrical connection to power source.
2. Factory mount transformer. Provide terminal strip in control box for field wiring of thermostat and power source.
3. Wiring Terminations: Wire fan and controls to terminal strip. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
4. Disconnect Switch: As scheduled.

2.3 CONTROLS

1. Direct digital controls: Contain in NEMA-1 enclosure with access panel sealed from air flow and mounted on side of unit. Factory-mount controls.

3. EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. Provide ceiling access doors or locate units above easily removable ceiling components. In no instance shall units be installed in inaccessible locations.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Connect to ductwork in accordance with Section 23 31 13.

- E. Verify that electric power is available and of the correct characteristics.
- F. Maintain a minimum of 18" clearance in front of VAV controller.
- G. Provide 3 straight duct diameters upstream of VAV box inlet.
- H. Flexible duct connections to VAV boxes are not permitted.

3.2 ELECTRICAL CONNECTIONS

- A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.
- B. Connect wiring in accordance with Division 26 Requirements.
- C. Ground equipment in accordance with Division 26 requirements.
- D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.3 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Division 26 requirements.

3.4 IDENTIFICATION

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 23 05 53 "HVAC Identification for equipment labels and warning signs and labels.

3.5 ADJUSTING

- A. Reset volume with damper operator attached to assembly allowing flow range modulation as indicated on equipment schedule.

END OF SECTION

SECTION 23 37 00 - AIR OUTLETS AND INLETS

1. GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/grilles.

1.2 REFERENCES

- A. See Section 23 05 00.

1.3 SUBMITTALS

- A. See Section 23 05 00.
- B. Product Data: For each type of product.
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Device Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

1.4 PROJECT RECORD DOCUMENTS

- A. See Section 23 05 00.

1.5 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500. Submit AMCA certification with submittal.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five (5) years documented experience.

2. PRODUCTS

2.1 CEILING DIFFUSERS

- A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

- B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.
- C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.
- D. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule.

2.2 WALL REGISTERS AND GRILLES

- A. General: Except as otherwise indicated, provide manufacturer's standard wall registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
- B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
- C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.
- D. Types: Provide wall registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.

3. EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
- C. Install diffusers to ductwork with adjustable elbow. Install maximum length of 5' of flexible duct upstream of each diffuser and grille, unless otherwise noted. See details on Drawings. All connections shall be air tight.
- D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly. Where a balancing damper has been omitted from drawing, consult engineer.
- E. Paint ductwork visible behind air outlets and inlets matte black.
- F. Provide return air sound boot on grilles as shown on drawings.

- G. Where slot diffusers or linear diffusers are located near perimeter windows, adjust at least one slot to direct air toward window.

END OF SECTION

SECTION 23 51 00 - BREECHINGS, CHIMNEYS, AND STACKS

1. GENERAL

1.1 SECTION INCLUDES

- A. Gas vent piping for water heaters.
- B. Combustion air piping for water heaters.

1.2 REFERENCE SECTION 23 05 00 FOR THE FOLLOWING:

- A. References.
- B. Submittals.
 - 1. Product Data: For the following:
 - a. Gas vent piping for water heaters.
 - b. Combustion air piping for water heaters.
 - 2. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.
 - a. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
 - 3. Product schedule including system, size, and vent/breeching/chimney/stack type.
- C. Quality Assurance.
 - 1. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.
- D. Coordination.

1.3 REGULATORY REQUIREMENTS

- A. Conform to applicable code, NFPA 54 (ANSI Z223.1) code for installation of natural gas burning appliances and equipment.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., or testing firm acceptable to the authority having jurisdiction] as suitable for the purpose specified and indicated.

2. PRODUCTS

2.1 NON-FOAM CORE CPVC PRESSURE PIPE

- A. Manufacturers: Subject to compliance with requirements, provide product by one of the following:

1. Charlotte Pipe
 2. Spears Manufacturing
 3. Or equivalent.
- B. Pipe and fittings shall be manufactured from virgin rigid CPVC (chlorinated polyvinyl chloride) vinyl compounds with a Cell Class of 24448 as identified in ASTM D 1784.
- C. CPVC pipe and fittings shall conform to ASTM D 2846. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer. All pipe and fittings shall be manufactured in the United States. Pipe and fittings shall conform to National Sanitation Foundation (NSF) Standards 14 and 61.

3. EXECUTION

3.1 EXAMINATION AND STORAGE

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Store delivered materials inside, out of the weather. Protect materials from accidental damage or vandalism.

3.2 INSTALLATION - GENERAL

- A. Installation shall comply with latest installation instructions published by the manufacturer and shall conform to all local plumbing, building and fire code requirements. Solvent weld joints shall be made using CPVC cement conforming to ASTM F 493. Yellow one-step cement may be used without primer. If a primer is required by local plumbing or building codes, then a primer conforming to ASTM F 656 should be used. The system shall be protected from chemical agents, fire stopping materials, thread sealant, plasticized vinyl products or other aggressive chemical agents not compatible with CPVC compounds.
- B. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- C. Support at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. Lap joints in direction of flow.
- F. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.
- G. Maintain minimum clearances from combustibles specified in UL listing.
- H. Level and plumb chimney and stacks.

- I. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

3.3 SCHEDULES

A. <u>EQUIPMENT</u>	<u>System</u>
Domestic Water Heaters	Non-Foam Core CPVC Pressure Pipe

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
- B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
- C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 23 51 00

SECTION 23 74 00 – PACKAGED OUTDOOR HVAC EQUIPMENT

1. GENERAL

1.1 SUMMARY

- A. Section Includes: Packaged rooftop units and commercial packaged, gas/electric units.

1.2 REFERENCES

- A. UL 60335-2-40 - Standard for Safety, Household and Similar Electrical Appliances - Safety - Part 2-40.
- B. AHRI 340 / 360 - Unitary Air-Conditioning Equipment.
- C. ASHRAE 90.1 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
- D. California Administrative Code - Title 24
- E. AHRI 370 Sound Rating of Large Outdoor Refrigeration and Air Conditioning Equipment.

1.3 RELATED SECTIONS:

- A. General: Comply with Section 23 05 00 requirements.
- B. Refer to section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
- C. Refer to specification section 23 09 93 – Sequence of Operations.
- D. Refer to specification section 23 74 01 – Rooftop Mechanical Equipment Screens.

1.4 ACTION SUBMITTALS

- A. Product Data: For each RTU.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - 5. Fans:
 - a. Include certified fan-performance curves with system operating conditions indicated.
 - b. Include certified fan-sound power ratings.

- c. Include fan construction and accessories.
 - d. Include motor ratings, electrical characteristics, and motor accessories.
 - 6. Include certified coil-performance ratings with system operating conditions indicated.
 - 7. Include filters with performance characteristics.
 - 8. Include gas furnaces with performance characteristics.
 - 9. Include factory selection calculations for each antimicrobial ultraviolet lamp installation.
 - 10. Include dampers, including housings, linkages, and operators.
- B. Shop Drawings: For each RTU.
- 1. Submit drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections.
 - 2. Submit product data indicating rated capacities, weights, accessories, service clearances and electrical requirements.
 - 3. Submit manufacturer's installation instructions.
- C. Delegated Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- 1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 3. Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.5 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's warranty.
- B. Seismic Qualification Data: Certificates, for RTUs, 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.
 - 4. Restraint of internal components.
- C. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."
- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force 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.
- D. Source quality-control reports.
- E. System startup reports.
- 1.6 CLOSEOUT SUBMITTALS
 - A. Operation and Maintenance Data:
 1. Submit operation and maintenance data.
 2. Include manufacturer's descriptive literature, start-up and operating instructions, installation instructions, and maintenance procedures.
- 1.7 MAINTENANCE MATERIAL SUBMITTALS
 - A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: **[One]** set(s) of filters for each unit.
 2. Gaskets: **[One]** set(s) for each access door.
 3. Fan Belts: **[One]** set(s) for each belt-driven fan.
- 1.8 QUALITY ASSURANCE
 - A. All work on units shall be accomplished by OEM factory trained and authorized servicing technicians
 - B. DELIVERY, STORAGE & HANDLING
 - C. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
 - D. Protect units from physical damage. Leave factory shipping covers in place until installation.
- 1.9 WARRANTY
 - A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first (ALL EQUIPMENT).
 - B. Provide 10 year limited warranty on full modulating gas heat exchanger.
 - C. Provide 5 year limited warranty for economizer.
 - D. Provide 5 year extended warranty for compressors.
 - E. Provide 5 year extended warranty for heat exchangers.

1.10 PERFORMANCE REQUIREMENTS

- A. When cULus is selected, unit shall conform to cULus for construction of packaged air conditioner and shall have cULus label affixed to rooftop package.
- B. Gas-fired heating rooftop units shall conform to ANSI Z21.47/Canadian Standards Association (CAN/CSA-2.3) for construction of packaged air conditioner.
- C. Gas-fired heating rooftop units shall conform to UL 795/Canadian Standards Association (CAN/CSA-3.2) for construction of packaged air conditioner.
- D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.
 - 1. Design RTU supports to comply with seismic performance requirements.
- E. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to ASCE 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.0.

2. PRODUCTS

2.1 PACKAGED ROOFTOP UNITS

- A. Summary:
 - 1. The contractor shall furnish and install packaged rooftop air conditioning unit(s) as shown and as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.
- B. Manufacturer:
 - 1. Trane
 - 2. Or approved equivalent.
- C. General:
 - 1. Units shall be specifically designed for outdoor rooftop installation on a seismic-rated roof curb and be completely factory assembled and tested, piped, internally wired, fully charged with R-454B compressor oil, factory run tested and shipped in one piece. Units shall be available for direct expansion cooling only, or direct expansion cooling with natural gas heating. Filters, outside air system, exhaust air system, non-fused disconnect switches and all operating and safety controls shall be furnished factory installed.
 - 2. All units shall be UL listed to US and Canadian Safety Standards. Cooling capacity shall be rated in accordance with AHRI Standard 360. All units shall have decals and tags to

aid in service and indicate caution areas. Electrical diagrams shall be printed on long life water resistant material and shall ship attached to control panel doors.

D. Casing:

1. Exterior panels shall be zinc-coated, galvanized steel painted with a slate gray air-dry finish durable enough to withstand a minimum of 672 hours consecutive salt spray application in accordance with standard ASTM B117. Screws shall be zinc-plus-zinc chromate coated.
2. Heavy gauge steel hinged access panels with tiebacks to secure door in open position shall provide access to filters and heating sections. Refrigeration components, supply air fan and compressor shall be accessible through removable panels as standard. Unit control panel, filter section, and gas heating section shall be accessible through hinged access panels as standard.
 - a. Provide optional double wall construction. Hinged access doors shall provide access to filters, return/exhaust air, heating and supply fan section. All access doors and panels shall have neoprene gaskets. Interior surfaces or exterior casing members shall have 1/2 inch fiberglass insulation.
3. Unit base shall be watertight with heavy gauge formed load-bearing members, formed recess and curb overhang. Unit lifting lugs shall accept chains or cables for rigging. Lifting lugs shall also serve as unit tie down points.

E. Refrigeration System:

1. The Trane Scroll compressor shall be industrial grade, direct drive 3600 RPM maximum speed scroll type. The motor shall be suction gas-cooled hermetic design. Compressor shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. Compressor shall also be provided with thermostatic motor winding temperature control to protect against excessive motor temperatures resulting from over-/under-voltage or loss of charge, high and low pressure cutouts, and reset relay.
2. Variable speed compressors shall be capable of speed modulation from 25 Hz to a maximum of 100 Hz. The minimum unit capacity shall be 15% of full load or less. The compressor motor shall be a permanent magnet type. Each compressor shall have a crankcase heater installed, properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles. Compressors shall be equipped with a bearing oil injection system that optimizes bearing and scroll set lubrication, sealing, and controls the oil circulation rate. Optimal bearing lubrication shall be provided by a gear oil pump.
3. Each variable speed compressor shall be matched with a specially designed variable frequency drive which modulates the speed of the compressor motor and provides several compressor protection functions. Control of the variable speed compressor and inverter shall be integrated with the IPak unit controller to ensure optimal equipment reliability and efficiency.

F. Power Supplies:

1. Unit shall be available with 460 voltage power supplies.

G. Ambient Control:

1. Variable speed condenser motors shall be provided to allow the unit to operate down to 0°F.

H. Evaporator Coil Drain Pan:

1. Drain pan shall be double sloping stainless steel and promote runoff of standing water from condensation inside the unit. Two drain pipes shall be installed through the base channel on each side of the unit. Drain pipe connection shall be installed through the side of the unit and connector size is 1.25 NPTI.

I. Leak Detection Sensor:

1. Unit shall be furnished with a leak detection system from the factory when a circuit refrigerant charge exceeds 4 lbs. The leak detection system shall consist of one or more refrigerant detection sensors. When the system detects a leak, the unit controller shall initiate mitigation actions as required by ASHRAE Std 15 and UL 60335-2-40.
2. "The leak detection system shall have the following BAS points:
 - a. Refrigerant LDS Input
 - b. Refrigerant Mitigation Active
 - c. Refrigerant LFL Concentration Sensor
 - d. Refrigerant LFL Concentration Alarm Threshold Sensor
 - e. Diagnostic: Refrigerant Concentration Sensor
 - f. Diagnostic: Refrigerant Leak Sensor Failure Sensor
 - g. Refrigerant Leak Sensor Communication Status Sensor"

J. Air-Cooled Condenser Coil:

1. Condenser coils shall have all aluminum microchannel coils. All coils shall be leak tested at the factory to ensure pressure integrity. The condenser coil shall be pressure tested to 650 psig. Subcooling circuit (s) shall be provided as standard.
 - a. Provide High Efficiency Condenser Coil option as required to meet scheduled performance. Option shall include additional rows of coil that provide increased efficiency compared to standard coils.

K. Air-Cooled Condenser Fans and Motors:

1. All condenser fans shall be vertical discharge, direct drive fans, statically balanced, with aluminum blades and zinc plated steel hubs. Condenser fan motors shall be three-phase motors with permanently lubricated ball bearings, built-in current and thermal overload protection and weather-tight slingers over motor bearings. Modulating condenser fans shall be provided on eFlex™ units.

L. Supply Fan:

1. Supply fan motors shall be open drip-proof. All supply fans shall be dynamically balanced in factory. Supply fan shall be test run in unit and shall reach rated rpm. All 60 Hz supply fan motors shall meet the Energy Independence Security Act of 2007 (EISA).
2. Forward-Curved Supply Fan: All supply fans shall have two independent fan assemblies with double inlet, forward-curved air foil fan, motor and fixed pitch sheave drive. All fans shall be statically and dynamically balanced and tested in factory. Supply fans shall be

test run in unit as part of unit test. Unit shall reach rated rpm before fan shaft passes through first critical speed. Fan shafts shall be mounted on two grease lubricated ball bearings designed for 200,000 hours average life.

3. Provide extended grease lines that allow greasing of bearings from unit filter section. Fan motor and fan assembly shall be mounted on common base to allow consistent belt tension with no relative motion between fan and motor shafts. Entire assemblies shall be completely isolated from unit and fan board by two-inch deflection spring isolators.

M. Electrical:

1. Unit shall be completely factory wired with necessary control and contactor pressure lugs or terminal block for power wiring. Units shall provide an option for a non-fused disconnect with external handle for safety.

N. Unit Voltage:

1. Rooftops shall be available with 460 voltage, 3 phase, 60 Hz power supplies.
2. Unit Interrupt Rating (Short Circuit Current Rating-SCCR)
 - a. A high fault SCCR option of 65,000A SCCR shall be provided for the unit.

O. Internal Shaft Grounding Ring

1. Motors shall have internal bearing protection for use with VFDs to provide a conductive discharge path away from the motor bearings to ground. Bearing Protection Rings shall be circumferential rings with conductive micro fibers which provide the path of least resistance and dramatically extend motor life.

P. Phase Monitor

1. Phase monitor shall protect 3-phase equipment from phase loss, phase reversal and phase imbalance. Any fault condition shall produce a Failure Indicator LED and send the unit into an auto stop condition. cULus approved.

Q. Non-Fused Disconnect

1. An external handle mounted on the control box door shall be provided to disconnect unit power with the control box door closed for safety.

R. Unit Controller:

1. The unit controller shall be factory installed and shall have a 7" user interface features a touch-sensitive color screen that provides facility managers with at-a-glance operating status, performance monitoring, scheduling changes and operating adjustments. Other advanced features include automated controller backup and optional features such as secure remote connectivity, wireless building communications, mobile device connectivity and custom programming with expandable I/O.

S. BACnet® Communication Interface

1. Rooftop controller communication interface shall use the BACnet protocol with an Ethernet (IEEE 802.3) or RS485 (EIA-485) physical interface and an appropriate data link technology as defined in ANSI®/ASHRAE® Standard 135-2012 (for example, BACnet/IP, BACnet/MSTP). The rooftop controller shall be BTL listed as a BACnet Advanced Application Controller (B-AAC) as defined in ANSI/ASHRAE Standard 135-2012.

T. Wireless Communication Interface Module (WCI)

1. Rooftop controller communication interface shall use the BACnet protocol with a ZigBee (IEEE 802.15.4) physical interface and an appropriate data link technology as defined in ANSI®/ASHRAE® Standard 135-2012. Wireless communication shall utilize open standard protocols, of which BACnet and ZigBee shall be considered appropriate.
2. Each rooftop controller wireless communication interface shall self-heal to maintain operation in the event of network communication failure.
3. Each zone sensor wireless communication interface shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications. Sensing options shall include temperature, relative humidity, CO2, and occupancy.

U. Power Monitor

1. Factory installed power meter shall measure unit energy usage to 0.2% accuracy (ANSI C12.20) and communicate through the unit controller enabling viewing through user interface or building automation system.

V. Controls Expansion Hardware

1. The rooftop controller shall have field applied controls capability. Factory installed expansion hardware shall have 19 inputs/outputs. Additional expansions may be added in the field.

W. Rapid Restart

1. Option provides immediate startup upon power failure. A backup generator shall be required on site before unit startup. Rapid Restart shall begin immediately after recovery from a power loss and work by restarting the compressors and supply fan quickly to provide full cooling within two to three minutes.

X. Operator Display

1. The roof top unit (RTU) shall include a 7-inch, touch-sensitive color screen that provides operating status, performance monitoring, and scheduling changes and operating adjustments.

Y. Secure Remote Access

1. Manufacturer shall provide secure remote access to the HVAC equipment with, or without, the presence of a Building Automation System. Secure remote access shall not require IP ports to be "exposed" (port-forwarded or external public IP addresses) to the Internet. Manufacturer shall update secure remote access software as necessary to follow cyber security best practices and respond to cyber security events.

Z. Filters

1. Filter options shall mount integral within unit and be accessible by hinged access panels.
2. Pre-Evaporator Filter Options (Combo 2"/4" filter rack)
 - a. High Efficiency Throwaway Option, MERV 8 (Pre-Filter)
 - 1) Shall be two-inch high efficiency media filters with average dust spot efficiency of 25-35 percent and an average arrestance in excess of 90 percent when tested in accordance with ASHRAE 52-76.
 - b. High Efficiency Throwaway Option, MERV 8 (Pre-Filter)
 - 1) Shall be 4-inch deep, high-efficiency pleated media filters with a minimum efficiency reporting value (MERV) of 11 when tested in accordance with ASHRAE Standard 52.2.

AA. Relief Air

1. Modulating Relief Fan Option
 - a. Two, double-inlet, forward-curved fans shall be mounted on a common shaft with fixed sheave drive. All fans shall be dynamically balanced and tested in factory before being installed in unit. Relief fan shall be test run as part of unit final run test. Unit shall reach rated rpm before fan shaft passes through first critical speed. Fan shaft shall be mounted on two grease lubricated ball bearings designed for 200,000-hour average life.
 - b. Optional extended grease lines shall be provided to allow greasing of bearings from unit filter section. Fan motor and assembly shall be mounted on common base to allow consistent belt tension with no relative motion between fan and motor shafts. Entire assembly shall be completely isolated from unit and fan board by spring isolation on motor sizes larger than 5 hp.
 - c. For VAV rooftops, the modulating relief discharge dampers (or VFD) shall be modulated in response to building pressure. A differential pressure control system, , shall use a differential pressure transducer to compare indoor building pressure to outdoor ambient atmospheric pressure. The FC relief fan shall be turned on when required to lower building static pressure setpoint.

BB. Outside Air

1. 0-100 Percent Modulating Economizer Option
 - a. Economizer option shall be operated through the primary temperature controls to automatically utilize outside air for "free" cooling. Automatically modulated return and outside air dampers shall maintain proper temperature in the conditioned space. Economizer shall be equipped with an automatic lockout when the outdoor high ambient temperature is too high for proper cooling.
 - b. Minimum position control shall be standard and adjustable at the user interface or through the building management system. A spring return motor shall ensure closure of OA dampers during unit shutdown or power interruption. Mechanical cooling shall be available to aid the economizer mode at any ambient. Standard

economizer dampers leakage rate shall be 2.5 percent of nominal airflow (400 cfm/ton) at 1 inch wg. static pressure.

CC. Ultra Low-Leak Economizer Damper Option

1. Economizer return and outside air dampers shall be provided with horizontal airfoil blades and spring-return actuators. The economizer shall have a functional life of 60,000 opening and closing cycles. Dampers shall be AMCA 511 Class 1A certified with a maximum leakage rate of 3 CFM/sq-ft at 1.0 in WC pressure differential thus exceeding requirements of ASHRAE 90.1-2013, California Title 24-2013, and IECC-2012.
2. Units ordered with ultra low leak economizers shall be listed on the California Energy Commission Registry for factory compliance with Title 24 Economizer and FDD requirements. A label shall be applied to the unit identifying construction with the ultra low leak economizer and FDD controls.
3. Ultra low leak motorized exhaust dampers shall be provided when the ultra low leak economizer is ordered with an exhaust/return option that includes motorized dampers. Ultra low leak motorized exhaust dampers shall be AMCA 511 Class 1A certified with a maximum leakage rate of 3 cfm/sq-ft at 1.0 in WC pressure differential. This exceeds the most stringent requirements of ASHRAE 90.1 and IECC (4 CFM/sq-ft at 1.0 in WC pressure differential).

DD. Economizer Control with Comparative Enthalpy

1. Two enthalpy sensors shall be provided to compare total heat content of the indoor air and outdoor air to determine the most efficient air source when economizing.

EE. Outside Air Measurement

1. A factory mounted airflow measurement station shall be provided in the outside air opening to measure airflow. The airflow measurement station shall measure from 40 CFM/ton to maximum airflow. The airflow measurement station shall adjust for temperature variations. Measurement accuracy shall meet requirements of LEED IE Q Credit 1 as defined by ASHRAE 62.1-2007.

FF. Gas-Fired Heating Option

1. All gas-fired units shall be completely assembled, have a wired, gas-fired heating system integral within unit, and fire tested prior to shipment. Units shall be cULus approved specifically for outdoor applications downstream from refrigerant cooling coils.
2. All gas heaters shall have 81% steady state efficiency, meeting the 2023 Department of Energy efficiency code. Gas-fired heating system control shall be fully integrated with the unit controls. Gas safety controls shall include electronic flame sensing capability, which proves combustion air prior to ignition sequence and during operation. The ignition sequence shall include a pre-purge cycle. Direct spark ignition shall be provided on all heat exchangers; ultra modulating heaters shall have direct spark ignition provided to the pilot line.
3. A three minute delay shall be provided between first and second stage gas valve operation on two-stage heaters.
4. Heat exchangers shall be drum and tube design with pre-mix burners. Free-floating design shall eliminate expansion and contraction stresses and noises. Heating system shall incorporate forced draft fans and include a chimney that exhausts away from the air intake. All gas heaters shall be made from grades of stainless steel suitable for

condensing situations. Gasketed cleanout plate shall be provided for maintenance and inspection of tubes/turbulators.

5. All gas piping shall be threaded connection with a pipe cap provided. Gas supply connection shall be provided through the side or bottom of unit. Heat exchanger shall be factory pressure and leak tested.

GG. Two-Inch Spring Isolators

1. Supply and relief/return fan assemblies shall be isolated with two-inch nominal deflection to reduce transmission of vibrations.
 - a. Requirement for spring isolators shall be evaluated in conjunction with seismic-rated curb.

HH. Access Doors

1. Hinged access doors shall provide easy access to supply fan, filters, exhaust/return fan, and the heating section. Double wall construction with dual density insulation sandwiched between heavy gauge galvanized steel panels for strength and durability can be selected.

II. Powered Convenience Outlet

1. A 15A, 115V Ground Fault Interrupter convenience outlet shall be factory installed. It shall be wired and powered from a factory mounted transformer. Unit-mounted, non-fused disconnect with external handle shall be furnished with factory powered outlet.

JJ. Extended Grease Lines

1. Lines shall allow greasing of supply and relief fan bearings through the filter access door.

KK. Accessories:

1. Roof Curbs:
 - a. Vibration isolating seismic roof curb: Thybar Vibro-Curb III or equal.
 - b. The Contractor shall supply and install a factory-fabricated combination roof mounting curb and vibration eliminator base. Base shall be designed so that it can be re-roofed without disturbing the rooftop unit. The vibration eliminating portion of the assembly shall be constructed of structural steel and designed to match perfectly with the bottom of the rooftop unit. The vibration eliminators shall be so designed to provide a minimum of 90% isolation efficiency with 2" deflection. The roof curb shall be supplied complete with wood nailing strip and continuous 9" rubber counter-flashing making the curb unit water-tight.

3. EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Verify that substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Protect units with protective covers during balance of construction.
- C. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- D. Provide for connection to electrical service. Refer to Div 26 specifications.
- E. Provide connection to refrigeration piping system and evaporators. Refer to Section 23 23 00. Comply with ASHRAE 15.
- F. Furnish charge of refrigerant and oil.
- G. Install units in accordance with manufacturer's instructions and regulations of authorities having jurisdiction.

3.3 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

3.4 DEMONSTRATION AND INSTRUCTIONS

- A. Section 23 05 00 demonstrating installed work.
- B. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- C. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
- D. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
- E. Provide cooling season start-up, and winter season shut-down for first year of operation.
- F. Inspect and test for refrigerant leaks every three months during first year of operation.

END OF SECTION

SECTION 23 74 01 – ROOFTOP MECHANICAL EQUIPMENT SCREENS

1. GENERAL

1.1 SECTION INCLUDES

- A. Pre-formed Panels: For enclosing roof top mechanical equipment.
- B. Aluminum Support Framing: For direct attachment of screening panels to mechanical equipment; no base or curb required unless shown otherwise on drawings.
- C. Sliding panels to permit easy access to mechanical equipment for servicing.
- D. Not Included in This Specification:
 - 1. Touch-up painting required for scratches and screw heads.
 - 2. Field painting of prime painted screens.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM B 221 - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire Profiles, and Tubes.
- B. The Aluminum Association, Inc. (AA):
 - 1. AA ADM-1516166 - Aluminum Design Manual.
- C. American Society of Civil Engineers (ASCE):
 - 1. ASCE 7-18 - Minimum Design Loads for Buildings and Other Structures.

1.3 RELATED SECTIONS:

- A. General: Comply with Section 23 05 00 requirements.
- B. Refer to specification section 23 74 00 – Packaged Outdoor HVAC Equipment

1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Data:
 - 1. Manufacturer's data sheets on each product to be used.

2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.
4. Typical installation methods.
5. Sufficient data and detail to indicate compliance with these specifications.

C. Verification Samples: Two representative units of each panel type.

1. Color Selection: Submit paint chart with full range of colors available for Architect's selection. Custom color samples available upon purchase.

D. Shop Drawings: Indicate layout heights, component connection details, and details of interface with adjacent construction.

1. Roof top mechanical equipment to be enclosed.

E. Certification: Manufacturer's Certificate of Compliance certifying that panels supplied meet or exceed requirements specified.

1. Professional Engineer stamped drawings.

F. Closeout Submittals: Warranty documents, issued and executed by manufacturer, countersigned by Contractor.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with a minimum of one year documented experience.

B. Installer Qualifications: Company specializing in performing Work of this section with minimum two years documented experience with projects of similar scope and complexity.

C. Source Limitations: Provide each type of product from a single manufacturing source to ensure uniformity.

1.6 PRE-INSTALLATION CONFERENCE

A. Convene a conference approximately two weeks before scheduled commencement of the Work. Attendees shall include Engineer, Contractor and trades involved. Agenda shall include schedule, responsibilities, critical path items and approvals.

1. Notify Engineer four (4) calendar days in advance of scheduled meeting date.

1.7 DELIVERY, STORAGE & HANDLING

A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.

B. Storage and Handling: Protect materials and finishes during handling and installation to prevent damage.

- C. Protect from damage due to weather, excessive temperature, and construction operations.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.
- B. Field Measurements: Take measurements of supporting paving, footings, or piers. Indicate measurements on shop drawings fully documenting any field condition that may interfere with the screen system installation.

1.9 COORDINATION

- A. Installer for work under this Section shall be responsible for coordination of panel and framing sizes and required options with the Contractor's requirements.
 - 1. Request information on sizes and options required from the Contractor.
- B. Submit shop drawings to the Contractor and obtain written approval of shop drawing from the Contractor prior to fabrication.

1.10 WARRANTY

- A. If any part of the rooftop equipment screen fails because of a manufacturing defect within 3 years from the date of substantial completion, the manufacturer will furnish without charge the required replacement parts. Any local transportation, related service labor or diagnostic call charges are not included.
- B. This warranty does not cover failure of your rooftop equipment screen if the Owner damages it, or if the failure is caused by improper installation. In no event shall the Warrantor be liable for incidental or consequential damages.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers:
 - 1. CityScapes International Inc
 - 2. Or approved equivalent.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Design Criteria:
 - 1. Rooftop Equipment Screens:

- a. The manufacturer is responsible for the structural design of all materials, assembly, and attachments to resist snow, wind, suction, and uplift loading at any point without damage or permanent set.
 - b. Framing shall be designed in accordance with the Aluminum Design Manual to resist the following loading:
 - 1) ASCE 7-18 - Minimum Design Loads for Buildings and Other Structures; American Society of Civil Engineers.
 - c. Default Clear Space Between Equipment and Screen: 36 inch (914 mm) nominal.
 - d. Standard Truss Sizes: 36 and 48 inch (1219 mm).
 - e. Screen Heights: 35, 52, and 70 inches (889, 1321, 1778 mm) and may be stacked as needed.
 - f. Corners may have one panel mounted at 45 degrees.
 - g. Screens may partially surround units.
 - h. Trusses: Should be spaced no further than 96 inches (2438 mm) along cabinet perimeter.
 - i. Screens Mounted to Steel Posts: Posts must be set no further than 96 inches (2438 mm) on center.
2. Design Requirements to be Supplied to Manufacturer:
- a. Obstructions above unit base rail elevation and within 72 inches (1829 mm) of unit must be identified.
 - b. Access panels, access doors, vent hoods, power disconnects, etc. must be accounted for in design; clearly noted on unit cut sheets or roof plans provided to Manufacturer.
 - c. Equipment Obstruction Details Provided to Cityscapes: Such as door swings, horizontal ducting, or piping may be made to run between top and bottom rails. Contact Manufacturer for custom solutions.
 - d. Post Mounting Systems: By others. Must have all steel sizing provided.
3. Limitations:
- a. Screens may be designed 22 to 60 inches (559 to 1524 mm) clear, as decided necessary by Manufacturer.
 - 1) Requests for special clearances should be noted.
 - b. Screen Heights:
 - 1) Cannot exceed 8 inches (203 mm) more than cabinet height.
 - 2) Units may have varying screen heights if needed to clear obstructions such as parapet walls.
 - c. Top Trim: May be added to cover as much of the unit above attachment points.
 - d. Screen Supports: To be attached below any drip edges.
 - e. Spans Between Supports Larger than 100 inches (2540 mm): May require a post mount support.
 - 1) Steel HSS by others.

f. Removable Screen Sections:

- 1) May be used for large maintenance clearances under special conditions:
- 2) Removable Sections:
 - a) Fit between two trusses.
 - b) Are not adjacent to one another; two trusses either side of section.
 - c) Are not placed on the ends of partially sided systems.

g. Units May be Nested Together If:

- 1) Cabinets are no further than 96 inches (2438 mm) apart.
- 2) Units have similar cabinet and curb heights.
- 3) Units are not on isolation/vibration curbs.

h. If nested look is desired but not possible from one of the reasons above, independent screens can be sized to fit together with small gaps.

2.3 MATERIALS

A. Thermoformed Plastic Panels: Fabricated from rigid medium impact thermo-formed ABS (Acrylic Butylene Styrene) sheets.

1. Minimum thickness: 3/16 inch (5 mm).

B. Powder Coated or Painted Metal Panels: Fabricated from rigid aluminum panels in multiple thicknesses.

1. Minimum Thickness: 0.050 inches (1.27 mm).

C. Perforated Metal Panels: Fabricated from rigid aluminum panels in multiple thicknesses.

1. Minimum Thickness: 0.063 inches (1.60 mm).

D. Framing: Aluminum Plate, Shapes and Bar: ASTM B 221, alloy 6061-T5 or 6063-T5.

E. Threaded Fasteners: Screws, bolts, nut, and washers to be Stainless steel.

1. Corner Assembly Fasteners: No. 12-14 x 1-1/4 inches (32 mm) stainless steel self-drilling screws.
 - a. Length: As required to develop full holding capacity of screw when fastened to Mechanical Equipment.
2. Provide lock washer or other locking device at all bolted connections.

2.4 FABRICATION

- A. Panels: Provide factory-formed panel systems with continuous interlocking panel connections and indicated or necessary components: Form all components true to shape, accurate in size, square and free from distortion or defects. Cut panels to precise lengths indicated on approved shop drawings.
- B. Trim and Closures: Material: Aluminum. Thickness: 0.050 to 0.25 inches (1.27 to 6.35 mm),
 - 1. Finish: Manufacturers standard coating system, unless shown otherwise on drawings.
- C. Framing: Fabricate and assemble components in largest practical sizes, for delivery to Project site.
 - 1. Corner Assemblies: Construct to required shape with joints tightly fitted.
 - 2. Components Required Framing Anchorage: Fabricate anchors and related components of material and finish as required, or as specifically noted.

2.5 FINISHES

- A. Aluminum Framing: Mill finish.
- B. Panel Coating: Manufacturer's standard powder coating system, factory applied.
 - 1. Color: Selected from full range of manufacturer's standard colors and approved by Architect.

3. EXECUTION

3.1 EXAMINATION

- A. Installer's Examination: Examine conditions under which construction activities of this section are to be performed.
 - 1. Submit written notification to Engineer and Screen manufacturer if such conditions are unacceptable.
 - 2. Beginning erection constitutes installer's acceptance of conditions.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install units in accordance with the manufacturer's instructions and approved shop drawings. Keep perimeter lines straight, plumb, and level. Provide brackets, anchors, and accessories necessary for a complete installation.
- B. Fasten structural supports to HVAC units without damaging the operation of the unit.

1. Provide corner and mid-span assemblies as required by approved shop drawings so that the panels are supported uniformly.
 2. Fastening bottom rail using bolts to permit ease of access to HVAC units.
- C. Insert panels into structural supports, except where fixed attachment points are indicated. Butt panels to adjacent panels for uniform fit. Fasten fixed panels in accordance with the shop drawings.
- D. Metal Separation: Where aluminum materials would contact dissimilar materials, insert rubber grommets at attachment points, thus eliminating where dissimilar metals would otherwise be in contact.
- E. Do not cut or abrade finishes which cannot be restored. Return items with such finishes to shop for required alterations.
- 3.4 ERECTION TOLERANCES
- A. Maximum misalignment from true position: 1/4 inch (6 mm).
- 3.5 CLEANING AND PROTECTION
- A. Remove all protective masking from material immediately after installation.
- B. Protection:
1. Ensure that the 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.
- C. Prior to Substantial Completion: Remove dust or other foreign matter from component surfaces; clean finishes in accordance with manufacturer's instructions.
1. Clean units in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 23 81 26 –SPLIT SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 RELATED SECTIONS

- A. Section 23 05 13 – Electrical Requirements for Mechanical Equipment.
- B. Section 23 23 00 – Refrigerant Piping and Specialties.
- C. Section 23 09 93 – Sequence of Operation.
- D. Section 23 05 93 – Testing, Adjusting and Balancing.

1.3 REFERENCES

- A. ARI 210 - Unitary Air-Conditioning Equipment.
- B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- C. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. IECC and ASHRAE 90.1 - Energy Conservation in new Building Design.

1.4 SUBMITTALS

- A. See Section 23 05 00.
- B. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.5 OPERATION AND MAINTENANCE DATA

- A. See Section 23 05 00.

1.6 QUALITY ASSURANCE

- A. Unit shall be rated in accordance with the latest edition of ARI Standard 210.
- B. Unit shall be certified for capacity and efficiency, and listed in the latest ARI directory.
- C. Unit construction shall comply with latest edition of ANSI/ ASHRAE and with NEC.
- D. Unit shall be constructed in accordance with UL standards and will carry the UL label of approval.
- E. Air--cooled heat pump and cooling coil condenser coils will be leak tested at 150 psig and pressure tested at 450 psig.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 23 05 00.
- B. Unit shall be stored and handled according to the manufacturer's recommendations.

1.8 WARRANTY

- A. The units shall have a manufacturer's parts and defects warranty for a period five (5) year from date of installation. The compressor shall have a warranty of seven (7) years from date of installation.

PART 2 - PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM

- A. Indoor, wall-mounted, direct-expansion fan coil shall be matched with the commercial condensing units.
- B. Indoor, direct-expansion, wall-mounted fan coil. Unit shall be complete with cooling coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, and integral temperature sensing. Unit shall be furnished with integral wall-mounting bracket and mounting hardware, and thermistor interconnection cable.
 - 1. Unit Cabinet: Cabinet discharge and inlet grilles shall be attractively styled, high-impact polystyrene. Cabinet shall be fully insulated for improved thermal and acoustic performance.
 - 2. Fans: Fan shall be tangential direct-drive blower type with air intake at the upper front face of the unit and discharge at the bottom front. Automatic, motor-driven vertical air sweep shall be provided standard Air sweep operation shall be user selectable. Horizontal direction may be manually adjusted (using remote controller) and vertical air sweep may be manually set.
 - 3. Coil: Coil shall be copper tube with aluminum fins and galvanized steel tube sheets. Fins shall be bonded to the tubes by mechanical expansion. A drip pan under the coil shall have a drain connection for hose attachment to remove condensate. Condensate pan shall have internal trap and auxiliary drip pan under coil header.
 - 4. Motors: Motors shall be open drip-proof, permanently lubricated ball bearing with inherent overload protection.
 - 5. Controls: Controls shall consist of a microprocessor-based control system which shall control space temperature, determine optimum fan speed, and run self-diagnostics. The temperature control range shall be from 64 F to 84 F. The unit shall have the following functions as a minimum.
 - a. An automatic restart after power failure at the same operating conditions as at failure.
 - b. Temperature-sensing controls shall sense return-air temperature. Indoor-air high discharge temperature shutdown shall be provided.
 - c. Indoor coil freeze protection.
Wired controller to enter set points and operating conditions.
 - d. Fan only operation shall provide room air circulation when no cooling is required.
 - e. Diagnostics shall provide continuous checks of unit operation and warn of possible malfunctions. Error messages shall be displayed at the unit and at the remote controller.
 - f. Fan speed control shall be user-selectable: high, medium, low, or microprocessor
 - g. automatic operation during all operating modes.
 - h. A time delay shall prevent compressor restart.

- i. Automatic heating-to cooling changeover to provide automatic heating and cooling operation. Control shall include deadband to prevent rapid mode cycling.
 - j. Demand defrost shall be provided and shall minimize defrost cycles by internally adjusting defrost timing based on frost accumulation.
 - k. Indoor coil high temperature protection shall be provided to detect excessive indoor discharge temperature when unit is in heat pump mode.
- 6. Provide hardwired thermostat with LCD display and push button controls with unit. Remote, battery powered thermostat is not acceptable.
 - 7. Filters: Unit shall have filter track with factory-supplied cleanable filters.
 - 8. Electrical Requirements: Refer to the schedule for electrical requirements. Power and control connections shall have terminal block connections.
 - 9. Operating Characteristics: Refer to schedule for performance requirements.

C. Condensing Units

- 1. Outdoor-mounted, air-cooled split system outdoor section suitable for rooftop installation.
- 2. Unit shall consist of a hermetic or rotary compressor, an air-cooled coil, propeller-type blow-thru outdoor fans, accumulator, full refrigerant charge, and control box. Unit shall discharge air horizontally as shown on the contract drawings. Units shall function as the outdoor component of an air-to air cooling system.
- 3. Units shall be used in a refrigeration circuit matched to a duct-free cooling fan coil unit.
- 4. Air-cooled condenser coils shall be leak tested for R-454B operating pressures with the coil submerged in water.
- 5. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, compressor, full charge of R-454B refrigerant, and special features required prior to field start-up.
- 6. Unit Cabinet: Unit cabinet shall be constructed of galvanized steel, bonderized and coated with a baked-enamel finish.
- 7. Unit access panels shall be removable with minimal screws and shall provide full access to the compressor, fan, and control components.
- 8. Outdoor compartment shall be isolated and have an acoustic lining to assure quiet operation.
- 9. Fans: Outdoor fans shall be direct-drive propeller type, and shall discharge air horizontally. Fans shall blow air through the outdoor coil.
- 10. Outdoor fan motors shall be totally enclosed; single-phase motors with class B insulation and permanently lubricated sleeve bearings. Motor shall be protected by internal thermal overload protection.
- 11. Shaft shall have inherent corrosion resistance.
- 12. Fan blades shall be corrosion resistant and shall be statically and dynamically balanced.
- 13. Outdoor fan openings shall be equipped with PVC coated protection grille over fan and coil.
- 14. Compressor: Compressor shall be fully hermetic reciprocation or scroll type.
- 15. Compressor shall be equipped with oil system, operating oil charge, and motor. Internal overloads shall protect the compressor from overtemperature and overcurrent. Scroll compressors shall also have high discharge gas temperature protection if required.
- 16. Motor shall be NEMA rated class F, suitable for operation in a refrigerant atmosphere.
- 17. Reciprocating compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.

18. Compressor assembly shall be installed on rubber vibration isolators and shall have internal spring isolation. Compressors shall be single-phase or 3-phase as specified on the contract drawings.
19. Outdoor Coil: Coil shall be constructed of aluminum fins mechanically bonded to internally enhanced, seamless copper tubes, which are cleaned, dehydrated, and sealed.
20. Refrigeration Components: Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines with Schrader type fittings with brass caps, accumulator, pressure relief, and a full charge of refrigerant.
21. Controls and Safeties: Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control shall include the following:
 - a. Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
 - b. Automatic restart on power failure.
 - c. Safety lockout if any outdoor unit safety is open.
 - d. A time delay control sequence provided through the fan coil board, thermostat, or
 - e. controller.
 - f. High-pressure and liquid line low-pressure switches.
 - g. Liquid line low-pressure switches.
 - h. Automatic outdoor-fan motor protection.
22. Start capacitor and relay (single-phase units without scroll compressors).
23. The minimum safeties shall include the following:
 - a. System diagnostics.
 - b. Compressor motor current and temperature overload protection.
 - c. High-pressure relief.
 - d. Outdoor fan failure protection.
24. Electrical Requirements: Refer to schedule for electrical requirements. Unit electrical power shall be a single point connection. All power and control wiring must be installed per NEC and all local building codes. High and low voltage terminal block connections.
25. Special Features:
 - a. Low-Ambient Kit: Control shall regulate fan-motor cycles in Responses to saturated condensing, pressure of the unit. The control shall be capable of maintaining a condensing temperature of $100\text{ F} \pm 10\text{ F}$ with outdoor temperatures to -20 F .
 - b. Installation of kit shall not require changing the outdoor-fan motor.
 - c. Winter Start Control: Field supplied and installed winter start control shall permit
 - d. start-up for cooling operation under low-load conditions and at low-ambient
 - e. temperatures by bypassing the low-pressure switch for a 3-minute delay period.
 - f. Crankcase Heater (units with scroll compressors only):
 - g. Unit shall be shipped with a clamp-on compressor oil sump heater.
 - h. Hard Start Kit: Field installed accessory start capacitor and start relay shall give a hard boost to compressor motor at each start.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that required utilities are available, in proper location, and ready for use.
- B. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Protect units with protective covers during balance of construction.
- C. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- D. Provide for connection to electrical service. Refer to Section 262726.
- E. Provide connection to refrigeration piping system and evaporators. Refer to Section 232300. Comply with ASHRAE 15.
- F. Furnish charge of refrigerant and oil.

3.3 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.

3.4 DEMONSTRATION AND INSTRUCTIONS

- A. See Section 23 05 00 demonstrating installed work.
- B. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- C. Charge system with refrigerant and test entire system for leaks after completion of installation.
- D. Repair leaks, put system into operation, and test equipment performance.

END OF SECTION

SECTION 23 82 39 - TERMINAL HEAT TRANSFER UNITS

1. GENERAL

1.1 SECTION INCLUDES

- A. Electric unit heaters.
- B. Panel radiators.

1.2 REFERENCES AND REGULATORY REQUIREMENTS

- A. See Section 23 05 00.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Indicate location and arrangement of integral controls.
 - 7. Wiring Diagrams: Power, signal, and control wiring.
 - 8. Provide custom color chart for color selection by Architect.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
 - 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. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Cabinet Unit-Heater Filters: Furnish **[one]** spare filter for each filter installed.

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE AND HANDLING

- A. See Section 23 05 00.

1.9 SEQUENCING AND SCHEDULING

- A. See Section 23 05 00.
- B. Install cabinet unit heaters only after walls and ceiling are finished and painted.

1.10 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- C. Seismic Performance: Cabinet unit heaters are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2. PRODUCTS

2.1 ELECTRIC CABINET UNIT HEATERS

- A. Manufacturer: Qmark – CU Series or equivalent.
- B. Heaters shall be designed for a range of heating outputs. Units shall be available in wattages from 3,000 to 50,000 and voltages of 208, 240, 277, 480 and 600 in single and 3 phase options.
- C. Enclosures shall be 20 gauge (.035" min.) galvanized steel enclosure, deep drawn to add rigidity. Enclosure designed to withstand heavy-duty commercial and institutional use.
 - 1. Enclosures shall be chemically-treated to resist corrosion and then finished in baked enamel powder coating. Finish shall be mar and temperature-resistant. Color to be White.
 - 2. Wiring compartment to be located at the right side of the heater with a hinged door to allow full access to wiring and controls. Enclosure to include knockouts for wiring and locations for optional accessories.
 - 3. Enclosure to include removable grilles so that the orientation of the inlet and outlet air can be changed on site.
 - 4. Enclosure designed to allow for horizontal or vertical installation.
- D. Heaters shall be designed with advanced pull through airflow to allow air to be pulled across the elements for cooler element operation.
- E. Motor shall be direct drive, permanently lubricated, totally enclosed.
- F. Heating elements shall be constructed with nickel chromium wire encased in a steel sheath or stainless steel sheath, and MgO material. Aluminum fins are to be designed for a chimney effect to maximize airflow and pressure bonded to the steel sheath for efficient heat transfer. Elements shall be U-shaped to maximize heat transfer.
- G. Built-in optional controls shall be capable of installing in the standard unit enclosure with no separate control box needed. The built-in optional controls shall include single pole thermostat, Two stage thermostat, Digital Touchscreen Thermostat with BMS, and power disconnect switch.
- H. Refer to schedule on drawings for accessories required including base kits, trim kits, and ducting options.
 - 1. Provide trim kit suitable for installation shown on plan.
- I. Heater shall include an automatic reset thermal overload protector that shall run the full-length of the heater and shall turn off heating elements should overheating occur at any point along heating length. Automatic reset overload protector shall restore operation automatically when cause of overheating is removed.

2.2 PANEL RADIATORS

- A. Manufacturer: Runtal model EBP or approved equivalent.
- B. General: Provide pedestal-mounted panel radiators of lengths and in locations indicated on the plans. Provide units of capacities, styles, features and accessories as scheduled.
- C. Panels: Panels shall be manufactured of cold rolled low carbon steel, fully welded and consisting of heating elements concealed by flat oval water panels for a finished look on both sides.

- D. Finish: Factory applied baked enamel finish on covers and accessories. Color is to be selected from the manufacturer extended color chart.
- E. Accessories as required by installed location: Provide all necessary end panels, outside and inside corner panels, and enclosure extensions to completely conceal all electrical and control wiring.
- F. Provide 5-year limited warranty.

3. EXECUTION

3.1 EXAMINATION

- A. Verify that required utilities are available, in proper location, and ready for use.
- B. Coordinate to assure correct recess size for recessed units.
- C. Beginning of installation means installer accepts existing surfaces.

3.2 INSTALLATION

- A. Electric fan forced cabinet unit heater installation:
 - 1. Coordinate mounting height of wall-mounted units with Architect prior to installation.
 - 2. Install Electric Fan Forced Cabinet Unit Heater complete with built in mounting features and controls, and provide branch circuits and controls.
 - 3. Complete installation shall conform to UL standards and shall also be in accordance with manufacturer's specification as listed by UL.
 - 4. Unit Heater shall be a minimum of seven feet above the floor, as listed in manufactures installation instructions.
 - 5. All other recommended clearances defined by the manufacture must be met.
 - 6. In-coming power must match nameplate rated voltage of the heater. Connections by approved methods.
 - 7. Branch circuit installation:
 - a. Provide Branch Circuits for the Following Items:
 - 1) Electric fan forced unit heater.
 - b. Provide local switch to disconnect power for heating equipment and the necessary wiring.
 - 8. Controls:
 - a. Provide controls as per specifications noted on drawings.
 - b. Control voltage to be 24 volts on all units
 - 9. Testing:
 - a. Perform adjustments and tests, including setting of thermostats furnished under this Section to assure satisfactory operation.

B. Panel Radiators:

1. Verify electrical supply wiring is the same voltage as the electric baseboard heater prior to ordering unit or installing.
2. Install per manufacturer's instructions.
3. Locate panel radiators as indicated on plans. Install elements as indicated on plans. Install accessories as noted on the plans. Provide backing inside the wall cavity or floor stands as recommended by the manufacturer. Coordinate exact mounting height and locations with architectural drawings.

3.3 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. Comb all bent fins on coils.

END OF SECTION

SECTION 26 05 00
ELECTRICAL GENERAL PROVISIONS

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1-specification sections, apply to work of this Section.
- B. Reference Specification section "23 05 48 – Seismic and Vibration Isolation Controls for HVAC, Plumbing, Fire Suppression, and Electrical Building Systems" for seismic requirements for electrical and low voltage systems.

1.2 DESCRIPTION OF WORK

- A. The work included under this Section consists of providing all labor, materials, supervision, and construction procedures necessary for the installation of the complete electrical systems required by these specifications and/or shown on the drawings of the contract.
- B. The Contract Drawings are shown in part diagrammatic intended to convey the scope of work, indicating the intended general arrangement of equipment, conduit, and outlets. Follow the drawings in laying out the work and verify spaces for the installation of the materials and equipment based on the dimensions of actual equipment furnished. Whenever a question exists as to the exact intended location of outlets or equipment, obtain instructions from the Engineer before proceeding with the work.

1.3 QUALITY ASSURANCE

Installers shall have at least 2 years of successful installation experience on projects with electrical installation work similar to that required by the project. All equipment and materials shall be installed in a neat and workmanlike manner and shall be aligned, leveled, and adjusted for satisfactory operation.

1.4 REFERENCES

- A. The design, manufacture, testing, and method of installation of all equipment and materials furnished under the requirements of this specification shall conform to the following codes, standards and regulations, etc.:
 - 1. Safety and Health Regulations for Construction.
 - 2. Occupational Safety and Health Standards, National Consensus Standards and Established Federal Standards.
 - 3. National Electrical Code (NEC).
 - 4. American National Standards Institute (ANSI).
 - 5. National Electric Manufacturer's Association (NEMA).
 - 6. Institute of Electrical and Electronic Engineers (IEEE).
 - 7. National Fire Protection Association (NFPA).
 - 8. Insulated Cable Engineers Association (ICEA).
 - 9. American Society for Testing and Materials (ASTM).
 - 10. Life Safety Code NFPA #101.
 - 11. Underwriters Laboratories, Inc. Standards (UL).
 - 12. Factory Mutual Engineering Corporation or other recognized National Laboratories.
 - 13. National Electrical Safety Code (NESC).

- B. The latest adopted edition by the local and state inspection authorities of all standards and specifications listed above shall apply.
- C. Furthermore, the electrical work shall be in accordance with all applicable National and State Standards, and Local Codes and Building Ordinances. The electrical work shall merit the approval of the enforcing authorities having jurisdiction.

1.5 MATERIALS AND EQUIPMENT

- A. Electrical materials and equipment for the entire project shall meet the requirements specified under the Supplementary Conditions Section of this specification.
- B. Equipment and fixtures shall be connected to provide circuit continuity in accordance with applicable Codes whether or not each piece of conductor, conduit, or protective device is shown between such items of equipment or fixtures and the point of circuit origin.
- C. The electrical work includes the installation or connection of certain materials and equipment furnished by others. Verify all connection details.
- D. All equipment over 50 pounds shall be provided with adequate lifting means.

2. PRODUCTS (NOT USED)

3. EXECUTION

3.1 ACCESS TO EQUIPMENT

- A. Starters, switches, receptacles, pull boxes, etc. shall be located to provide easy access for operation, repair and maintenance. If the devices listed above are concealed, access doors shall be provided.

3.2 SUBMITTALS

- A. Test Reports: Provide the tests as outlined in this specification and all other tests necessary to establish the adequacy, quality, safety, completed status, and suitable operation of each electrical system. Provide the Engineer with a complete schedule of all tests.
 - 1. Ground Rod Test: Immediately after installation, test driven grounds and counterpoises with a ground resistance direct-reading single-test megger, using the AC fall-of-potential method and two reference electrodes. Orient the ground to be tested and the two reference electrodes in a straight line spaced 50 feet apart. Drive the reference electrodes five feet deep. Disconnect the ground rod to be tested from other ground systems at the time of testing. The ground resistance for the electrical service must be 15 Ohms or less. Submit the results, date of test, and soil conditions to the Engineer in writing immediately after testing.
 - 2. Final Tests: Start final tests after complete preliminary tests have been made which indicate adequacy, quality, completion, and satisfactory operation of all electrical systems. Included in these tests are the following:
 - a. Completion of the form "Electrical Test Report" (attached to the end of this specification section) in sufficient quantity to provide the indicated information for each panelboard and switchboard in the project.
 - b. Completion of the form "Motor Test Report" (attached to the end of this specification section) in sufficient quantity to provide the indicated information for all three phase motors.

3. The Contractor shall submit the above completed reports to the Engineer, noting all deviations from the requirements listed below:
 - a. Plus or minus five percent variation between nominal system voltage and no load voltage, or plus or minus five percent variation between no load and full load voltage.
 - b. Plus five-percent variation between rated and actual motor current.
 - c. Plus or minus ten percent variation between average phase current and measured individual phase current. The Contractor shall balance phase currents of all distribution equipment within the tolerances specified.
 - d. Insulation resistance between conductors and ground of not less than 1,000,000 Ohms.
 4. Final Corrections: Correct promptly any failure or defects revealed by these tests as determined by the Engineer. Reconduct tests on corrected items as directed by the Engineer.
- B. Operation and Maintenance Manuals: Operation and Maintenance Manuals shall be provided according to Division 1 requirements. In general, during the time of the contract, and before substantial completion of the electrical installation, submit to the Engineer the number of copies described in the Division 1 specifications and the General and Supplemental Conditions copies of descriptive literature, maintenance recommendations (from the equipment manufacturer), data on initial operation, wiring diagrams, performance curves, engineering data and tests, operating procedures, routine maintenance procedures, and parts lists for each item of electrical equipment installed under this contract and submit all manufacturer's guarantees and warranties.
- C. Shop Drawings: The Contractor shall furnish shop drawing portfolios and proper transmittal forms for all materials, equipment, and lighting fixtures to be incorporated in the work in accordance with the General Conditions, Supplementary Conditions, and all other applicable Conditions.
1. Shop drawings on component items forming a system or that are interrelated shall be submitted at one time as a single submittal in order to demonstrate that the items have been properly coordinated and will function properly as a system. A notation shall be made on each shop drawing submitted as to the item's specific use, either by a particular type number referenced on the drawings or in the specifications, by a reference to the applicable paragraph of the specifications, or by a description of its specific location. The shop drawings shall be organized and bound into sets with each set collated.
 2. The Engineer shall have the final authority as to whether the equipment or material submitted is equal to the specified item. Proposed substitutions may be rejected for aesthetic reasons if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.
- D. A coordination study shall be provided by the contractor for this project. The study shall include maximum short circuit calculations, a complete coordination analysis, and settings for all protective devices with adjustable set points. The protective device settings must address the need to minimize arc flash hazards while maintaining proper system coordination. **The study shall be submitted along with and at the same time as the shop drawings for all pertinent electrical distribution equipment. Electrical distribution equipment shall not be released for purchase until study has been reviewed and approved by engineer.** The coordination study shall be based on the specific devices installed and include all new equipment and all existing equipment required in order to complete the study for the new equipment (including, but not be limited to) the following:
1. Service Entrance Equipment.

- a. All overcurrent protective devices installed in service entrance panels/switchboards.
 2. Feeder Circuits.
 - a. All three (3) phase feeder circuit overcurrent protective devices.
 3. Branch Circuits.
 - a. All three (3) phase branch circuit overcurrent protective devices. installed with a rating equal to or greater than 30 amps.
 - b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.
 4. Motor Control Centers
 - a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.
 5. Format
 - a. The coordination study shall be reviewed and updated to reflect any changes within one week of the final electrical walk through for project.
 - b. The low voltage coordination study shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed by the Engineer of Record.
 - c. A complete set of manufacturers' descriptive literature and detailed instructions for adjusting overcurrent protective devices shall be provided to the Owner's Representative within six (6) weeks after overcurrent protective device shop drawings have been approved.
 - d. The low voltage coordination study shall be provided using the SKM Systems Analysis, Inc SKM Power Tools Electrical Engineering Software (PTW 32).
 - e. Prior to project completion, the low voltage coordination study shall be provided to the Owner's Representative in both hard copy and on flash drive. The hard copy shall include time current curves (for phase and ground fault settings) for each panel and the corresponding TCC report clearly showing each device set point. The flash drive shall include the complete coordination file including all device curves (use the SKM "Project - Backup" command).
- E. A low voltage Arc Flash Hazard Analysis shall be provided by the contractor for this project. The analysis shall be based on the specific equipment installed, and shall be updated to include project "as built" documentation. Where the arc flash hazard/risk category is equal to or greater than 8 cal/cm², the overcurrent protective device coordination study shall be reviewed and recommendations shall be provided to reduce the hazard/risk level. **The Arc Flash Hazard Analysis shall be submitted along with and at the same time as the shop drawings for all pertinent electrical distribution equipment. Electrical distribution equipment shall not be released for purchase until the analysis has been reviewed and approved by engineer.** The analysis shall be based on the specific devices installed and include (but not be limited to) the following:
1. Service Entrance Equipment.
 - a. All overcurrent protective devices installed in service entrance panels/switchboards.
 2. Feeder Circuits.

- a. All three (3) phase feeder circuit overcurrent protective devices.
- 3. Branch Circuits.
 - a. All three (3) phase branch circuit overcurrent protective devices installed with a rating equal to or greater than 30 amps.
 - b. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.
- 4. Motor Control Centers.
 - a. All motor circuit overcurrent protective devices for motors with a rating equal to or greater than 10 horse power.
- 5. The project shall include printed color, waterproof labels for equipment that lists the specific arc flash hazard/risk category at each location.
 - a. For incident energy values greater than 40 cal/cm², label shall indicated "WARNING" using black lettering on orange background.
 - b. For incident energy values greater than 40 cal/cm², label shall indicated "DANGER" using white lettering with red background.
 - c. Labels installed outdoors shall be resistant to ultraviolet lighting.
 - d. At a minimum, each label shall list the following:
 - 1) Location
 - 2) Source protective device name providing the protection (fed from)
 - 3) Nominal system voltage
 - 4) Arc flash boundary
 - 5) Specific arc incident energy available
 - 6) Bolted fault current available
 - 7) Label date
- 6. Format
 - a. The Arc Flash Hazard Analysis shall be reviewed and updated to reflect any changes and corrections to conductor length within one week of the final electrical walk through for the project.
 - b. The low voltage arc flash hazard analysis shall include the stamp or seal and signature of the preparing engineer, and shall be reviewed by the Engineer of Record.
 - c. Owner approved Arc Flash Hazard warning labels shall be furnished and installed prior to project completion.
 - d. The low voltage arc flash hazard analysis shall be provided using the SKM Systems Analysis, Inc SKM Power Tools Electrical Engineering Software (PTW 32).
 - e. Prior to project completion, the low voltage arc flash hazard analysis shall be provided to the Owner's Representative in both hard copy and on flash drive. The hard copy shall clearly show each device set point. The flash drive shall include the complete coordination file including all device curves (use the SKM "Project - Backup" command).

3.3 EXISTING UTILITIES

- A. The Contractor shall verify the location of all existing utilities with the Owner and Utility providers prior to commencing excavation work. In addition, the contractor is responsible for locating and

maintaining all existing utilities without damage. Fully coordinate all new underground utility work with existing utilities on the site. The drawings and survey data of the contract documents indicate the available information on the existing power and communication services, and on new services to be provided to the project by utility provider. Accuracy of this information is not assured.

3.4 ELECTRICAL SERVICE

- A. The Contractor shall provide all material and pay all fees required by the local utility provider for the connection of the new electrical service as shown on the plans. The Contractor shall also meet all equipment requirements of the local utility provider. The Contractor shall provide all necessary materials for construction of the temporary electrical service and shall coordinate all details with the local utility provider.

3.5 TELECOMMUNICATIONS SERVICE

- A. The telecommunications services to the building are as indicated on the drawings. Arrange all service details with the local telecommunications provider and pay all costs and fees assessed to the project. All work shall be in accordance with the local telecommunications provider's standards and subject to their approval. Coordinate the installation of service entrance equipment with the telecommunications provider prior to the start of construction.

3.6 SMOKE AND SMOKE/FIRE DAMPERS

Provide all necessary duct detectors for smoke and smoke/fire dampers. In addition, provide all necessary connections, including power supply circuits (fed from the nearest panelboard, emergency if available, of the appropriate voltage unless indicated otherwise on the drawings) to smoke dampers and smoke/fire dampers so that upon fire alarm conditions or integral smoke detector activation, the dampers close. Coordinate damper and control locations with the mechanical and controls contractors. Refer to the mechanical drawings for damper schedule and locations.

3.7 ELECTRICAL-MECHANICAL EXTENT OF WORK

- A. The responsibility of work specified under Divisions 21, 22, 23 and 26 is clarified under, Sections 21 05 00, 22 05 00 and 23 05 00. Said Sections are incorporated herein by reference.

3.8 ELECTRICAL PRODUCT COORDINATION

- A. Refer to Division 2 through Division 32 and the electrical drawings for the power characteristics required and available for the operation of each power-consuming item of equipment. Coordinate purchases to ensure uniform interface with every item requiring electrical power.

3.9 CUTTING AND PATCHING

- A. The Electrical Contractor shall be responsible for all cutting and patching of holes in building construction which are required for the passage of electrical work. Cutting and patching shall conform to the requirements of Division 1 and, if applicable, Division 2 of these specifications.
- B. Cutting of structural framing, walls, floors, decks and other members intended to withstand stress is not permitted.

3.10 PAINTING, FINISHING

- A. Painting of electrical work exposed in occupied spaces, except mechanical and electrical machine rooms and maintenance/service spaces; and work exposed on the exterior of the facility is specified and performed under other divisions of these specifications.
- B. Factory finishes, shop priming, and special protective coatings are specified in the individual equipment specification sections.
- C. Where factory finishes are provided on equipment and no additional field painting is specified, all marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish at the time of final inspection.

3.11 EXCAVATION AND BACKFILLING

- A. Contractor shall perform all excavation and backfilling necessary to install the required electrical work. Coordinate the work with other excavating and backfilling work in the same area. Except as indicated otherwise, comply with the applicable sections in Division 31 of these specifications, excavation filling and backfilling (for structures) to 5' outside the building line, and exterior utilities sections for beyond 5' from the building line.
- B. Landscape work, pavement, flooring and similar exposed finish work that is disturbed or damaged by excavation shall be repaired and restored to their original condition by the Contractor.

3.12 CONDUITS AND SUPPORT, GENERALLY

- A. Conduits, except electrical conduits run in floor construction, shall be run parallel with or perpendicular to lines of the building unless otherwise noted on the drawings. Electrical conduits shall not be hung on hangers with any other service, unless specifically approved by the Engineer. Electrical conduits shall be hung above all other service pipes. Hangers on different service lines running close to and parallel with each other shall be in line with each other and parallel with, or perpendicular to, the lines of the building. Exact location of electric outlets, piping, ducts, and the like shall be coordinated to avoid interferences between lighting fixtures, piping, ducts, and similar items.

3.13 ACCESS PANELS

- A. Furnish and install panels for access to junction boxes and similar items where no other means of access, such as a readily removable, sectional ceiling is shown or specified.
- B. Panels shall not be less than 12-inches by 16-inches in size. Larger panels shall be furnished where required. Panels in tile or other similar patterned ceilings shall have dimensions corresponding to the tile or pattern module.
 - 1. Refer to Section 08 31 13 – Access Doors and Panels for specific information on type and size of panels

3.14 INSTALLATION OF EQUIPMENT

- A. Install and connect all appliances and equipment as specified and indicated for this project, in accordance with the manufacturers' instructions and recommendations. Furnish and install complete electric connections and devices as recommended by the manufacturer or required for proper operation.

3.15 COORDINATION

- A. Coordinate the electrical work with work of the different trades so that:
 - 1. Interferences between mechanical, electrical, architectural, and structural work, including existing services, will be avoided.
 - 2. Within the limits indicated on the drawings, the maximum practicable space for operation, repair, removal and testing of electrical and other equipment will be provided.
 - 3. Pipe, conduits, ducts, and similar items, shall be kept as close as possible to ceiling, walls, and columns, to take up a minimum amount of space. Pipes, conduits, ducts, and similar items shall be located so that they will not interfere with the intended use of other equipment.
- B. Furnish and install, without additional expense to the Owner, all offsets, fittings and similar items necessary in order to accomplish the requirements of coordination.
- C. Before any sleeves or inserts are set, or any electrical equipment or foundations are installed, prepare and submit for approval composite coordination drawings for all equipment rooms, and other areas in which work of two or more trades or subcontractors is to be installed and in which the probability of interference exists. Drawings shall show the work of all trades covered, shall be drawn to a scale not smaller than 1/2" = 1'-0", and shall show clearly in both plan and elevation that all work can be installed without interference.
- D. Any work installed prior to approval of coordination drawings shall be at the Contractor's risk. Subsequent relocations required to avoid interference's shall be made without additional expense to the Owner.

3.16 SINGULAR NUMBER

- A. Where any device or part of equipment is herein referred to in the singular number (such as "the switch"), such reference shall be deemed to apply to as many such devices as are required to complete the installation as shown on the drawings.

3.17 WARRANTY

- A. Refer to the General Conditions section of this Specification for warranty requirements and information.

3.18 CLOSE OUT AND OPERATION INSTRUCTIONS

- A. Sequence operations properly so that all work of this project will not be damaged or endangered. Operate each item of equipment and each system in a test run of appropriate duration to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance.
- B. Conduct a full-day walk-through instruction seminar for the Owner's personnel to be involved in the continued operation and maintenance of electrical equipment and systems. Explain the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, security, safety, efficiency and similar features of the systems.
- C. At the time of substantial project completion, turn over the prime responsibility for operation of the electrical equipment and systems to the Owner's operating personnel. Until the time of final acceptance, provide full time operating personnel, who are completely familiar with the work, to consult with and continue training the Owner's personnel.

SUBSTITUTIONS

D. All proposals shall be based on providing and installing the materials or items of equipment which are hereinafter specified by name and/or manufacturer. Substitutions, for materials or items of equipment specified, will not be allowed, unless approved by Engineer prior to (10 days before) bid date.

E. Refer to Instructions to Bidders for complete requirements for substitutions.

3.19 AS-BUILT DRAWINGS

A. Contractor shall provide the Owner with as-built drawings for all electrical systems as described in these specifications and/or shown on the Drawings.

END OF SECTION 26 05 00

MOTOR TEST REPORT

DATE: _____

SHEET NO. _____ OF _____

PROJECT NAME: _____

PROJECT NUMBER: _____

DESIGNATION						
LOCATION						
HORSEPOWER						
NEMA STARTER SIZE						
MAXIMUM HEATER AMPS						
MEASURED CONDITIONS	PHASE			PHASE		
	A	B	C	A	B	C
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						

DESIGNATION						
LOCATION						
HORSEPOWER						
NEMA STARTER SIZE						
MAX HEATER AMPS						
MEASURED CONDITIONS	PHASE			PHASE		
	A	B	C	A	B	C
ACTUAL MOTOR CURRENT						
NAMEPLATE MOTOR CURRENT						
NO LOAD VOLTAGE						
FULL LOAD VOLTAGE						

ELECTRICAL TEST REPORT

DATE: _____

SHEET NO. _____ OF _____

PROJECT NAME: _____

PROJECT NUMBER: _____

SERVICE TRANSFORMER SIZE	
NO LOAD SERVICE VOLTAGE	
FULL LOAD SERVICE VOLTAGE	

DESIGNATION									
LOCATION									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	B	C	A	B	C	A	B	C
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									

DESIGNATION									
LOCATION									
MEASURED CONDITIONS	PHASE			PHASE			PHASE		
	A	B	C	A	B	C	A	B	C
NO LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER VOLTAGE									
OPERATING LOAD FEEDER CURRENT									

SECTION 26 05 01
BASIC MATERIALS AND METHODS

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.

B. Seismic Requirements:

- 1. Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
- 2. Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.**
- 3. "Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. Egress Lighting: $I_p = 1.5$**
 - b. Egress lighting Inverter and circuitry to associated lights: $I_p = 1.5$**
 - c. Exit signs: $I_p = 1.5$**
 - d. Fire Alarm System: $I_p = 1.5$.**
 - e. All other components: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. The extent of Basic Materials and Methods is indicated by the drawings and specifications. Basic materials are defined but not limited to cable and conduit seals, outlet boxes, pull boxes, conduit fittings, safety switches, and fuses.

1.3 QUALITY ASSURANCE

- A. Manufacturers: All materials shall be new, unused, and unweathered, and of the quality specified. Materials shall be standard products of manufacturer's regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design.
- B. Installer: All equipment and materials shall be installed in a neat and workmanlike manner, shall be complete in both effectiveness and appearance, whether finally concealed or exposed and shall be executed by experienced mechanics.

1.4 REFERENCES

- A. The electrical work shall conform to all applicable sections of standards, codes and specifications promulgated by organizations listed below.
 - 1. Occupational Safety and Health Standard, National Consensus Standards and Established Federal Standards
 - 2. National Electrical Code (NEC)
 - 3. National Electric Manufacturer's Association (NEMA)
 - 4. American Society for Testing of Materials (ASTM)
 - 5. Underwriters Laboratories, Inc. Standards (UL)
 - 6. Factory Mutual Engineering Corporation or other Recognized National Laboratories

1.5 SUBMITTALS

- A. Shop drawings: Prepare a set of shop drawings showing manufacturers product data for all component parts specified in this Section.

2. PRODUCTS

- 2.1 Equipment and Materials Furnished by Others: Certain materials and equipment for this project will be furnished under other divisions. These materials and equipment, which are shown or noted on the plans, will be installed and/or connected under this Division. It shall be incumbent upon this Contractor to become familiar with all of the materials and equipment that will be furnished under other Divisions, but which will be installed and/or connected under this Division.

- 2.2 Cable and Conduit Seals: Seals shall be provided around all conduits and cables which penetrate smoke walls, fire walls, and floors. Nelson Flameseal System shall be used to seal penetrations of electrical cables and conduits.

- A. Materials used shall be flameseal putty, ceramic fiber insulation and where rigid support on large oversized openings is required, ceramic fiber board. Board shall be rigid and able to withstand temperatures in excess of 2000 degrees F.

- B. Accessory hardware shall be provided as required on oversized openings.

- C. Follow manufacturers instructions in selecting the type of seals and accessories. Also follow the manufacturers instructions on installation of the cable and conduit seals. Equal quality equipment by OZ Gedney and 3M shall be acceptable.

- 2.3 Outlet Boxes, Pull Boxes and Conduit Fittings: Furnish and install outlet boxes, pull boxes, and conduit fittings as described below. Catalog numbers shown are Appleton Electric Company; Steel City, O.Z. Gedney, and Raco, are equally acceptable.

A. OUTLET BOXES

1. Lighting Boxes (concealed)	No. 40-3/4
2. Lighting Boxes (concrete)	OCR Series
3. Lighting Boxes (exposed)	4S-3/4 or 40-3/4
4. Flush Switches, Receptacles	No. 4S-3/4 with separate

	and Flush Junction Boxes	extension plaster ring; M*-250 in masonry construction (* refers to number of devices in the box)
5.	Weatherproof type Switch and Receptacle Boxes (Exposed)	FS Series w/FS cover and neoprene gasket.
6.	Weatherproof type Telecommunications Boxes (exposed)	FD Series w/FD cover and neoprene gasket.
7.	Switch and Receptacle (exposed)	4S-3/4 with 8360 or 8370 series raised surface cover.
8.	Telecommunications Boxes	
- a. At minimum, the typical communications backbox shall be 4-11/16-inch square by 2-1/8-inch deep with 1-1/4-inch knockouts and a 4-11/16-inch square mud ring for one (1) device (single-gang) unless noted otherwise.
 - b. For flush mounted boxes, Manufacturer shall be:
 - 1) RACO/Hubbell Electrical Products – 4-11/16-inch Square Box, 2-1/8-inch Deep, 1-1/4-inch Side Knockouts. (P/N RACO259) with 4-11/16-inch square mud ring for one (1) device (verify appropriate Mud-Ring depth).
 - 2) Randl Industries, Inc. – 5-square Telecommunications Outlet Box (P/N T55017) with appropriate single gang mud ring.
 - 3) Or approved equivalent.
 - c. For outlets in CMU wall, submit appropriate backbox for application.
 - d. For outlets above ceiling for applications such as Wireless Access Points
 - 1) RACO/Hubbell Single-gang Galvanized Steel Box (P/N 2DDB6)
 - 2) Or approved equivalent.

B. Extension and plaster rings shall be installed as required by the NEC.

C. Outlet boxes shall comply with the National Electrical Code in regard to the allowable fill.

2.4 PULL BOXES

- A. Pull boxes shall be fabricated of code gauge galvanized sheet metal and shall be sized in accordance with the National Electrical Code requirements or as shown on the drawings. Provide removable cover on the largest access side of the box. In-line conduit pull boxes may be O.Z., Type PBW, or equal. Provide pull boxes at all code required locations, and as needed to aid in cable pulling.

2.5 SAFETY SWITCHES

- A. Furnish and install heavy duty type safety switches, having the electrical characteristics, ratings and modifications shown on the drawings. All switches shall have:
- B. NEMA 1 general purpose enclosures unless otherwise noted for all interior applications;

- C. NEMA 3R rainproof enclosures unless otherwise noted for all exterior applications;
- D. NEMA 4/4X stainless steel enclosures where noted on plans.
- E. Fully rated neutral assemblies;
- F. Equipment grounding kits;
- G. Metal nameplates, front cover mounted that contain a permanent record of switch type, catalog number and H.P. ratings with both standard and time delay fuses;
- H. Handle that is padlockable in "OFF" position;
- I. Non-teasible, positive quick-make, quick-break mechanism;
- J. UL approval and shall bear the UL label;
- K. All fusible switches shall have Class R Fuse rejection clips.
- L. Safety switches, as manufactured by the following, will be equally acceptable, but all safety switches furnished by this Contractor shall be the product of one manufacturer:
 - 1. Square D Company
 - 2. General Electric
 - 3. Cutler Hammer
 - 4. Siemens

2.6 FUSES

- A. Fuses shall be furnished and installed in each fused switch, and shall be rated as shown on the drawings.
- B. Provide fuses according to the following and in accordance with recommendations of manufacturers whose equipment is being protected:
 - 1. Provide UL Class L current limiting time-delay fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting transformers, motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
 - 2. Provide UL Class L current limiting fast-acting fuses rated 600-volts, 60 Hz, 601 to 6000 amps, with 200,000A RMS symmetrical interrupting current rating for protecting service entrances and main feeder circuit breakers. (Similar to Buss Limitron fuses.)
 - 3. Provide UL Class RK1 current limiting, dual-element, time-delay fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
 - 4. Provide UL Class RK1 current-limiting fuses rated 250-volts, 60 Hz, 1/10 to 600 amps, with 200,000A RMS symmetrical interrupting current for protecting motors and circuit breakers. (Similar to Buss Low-Peak fuses.)
 - 5. Provide UL Class J current-limiting fuses rated 600-volts, 60 Hz, 1 to 600 amps, with 200,000A RMS symmetrical interrupting current rating for protecting circuits with no heavy inrush current where reduced dimension devices are required.
 - 6. Provide UL Class H fuses rated 600-volts, 60 Hz, 1/10 to 600 amps, with 10,000A RMS symmetrical interrupting current rating for protecting general purpose light duty feeders.

7. Provide UL Class T fuses rated 600-volts, 60 Hz, 1 to 1,200 amps, with 200,000A RMS symmetrical interrupting current rating for protection of non-motor loads where reduced dimension devices are required.
- C. Three spare fuses shall be furnished for each size and type used. Each fused switch shall be provided with a mastic backed label clearly identifying the type and size of fuse required.

3. EXECUTION

3.1 PRODUCT INSTALLATION, GENERAL

- A. Except where more stringent requirements are indicated, comply with product manufacturer's installation instructions and recommendations, including handling, anchorage, assembly, connections, cleaning and testing.

3.2 MOUNTING HEIGHTS

- A. Mounting heights to the center of the box above finished floor for the items listed below shall be as follows, unless otherwise shown. All other device mounting heights shall be as shown on the drawings. All devices shall be mounted in accordance with ADA (Americans with Disabilities Act) requirements.
- B. Flush tumbler switches and lighting controls 46"
- C. Switches in concrete block 46"
- D. Switches over wainscot 6" above 48" wainscot
- E. Convenience outlets 18" mounted vertically with ground prong slot at bottom
- F. Safety switches 54"
- G. Motor controllers 54"
- H. Panelboards to top 72"
- I. Telecommunications outlets 18"
- J. Telecommunications outlets (pay and wall type) 54" for non-ADA type
44" for ADA type
- K. Receptacles above counters 8" above counters mounted vertically
- L. Convenience outlets in mechanical, electrical, telecommunications, janitor and elevator machine rooms 46"
- M. Exterior W.P. convenience outlets 24" above grade mounted

N.	Fire alarm pull station	46"
O.	Fire alarm horn, speaker, bell chime And/or strobe	84"
P.	Fire alarm door hold opens	Coordinate with door hardware supplier
Q.	Intercom System Pushbutton Stations	46"
R.	Card Readers	46"
S.	Contractor shall check all equipment layouts and verify exact mounting heights.	

3.3 CUTTING AND PATCHING FLOORS, WALLS OR CEILINGS

- A. Cutting, patching, repairing, and finishing of carpentry work, metal work, or concrete work, etc., which may be required for this work shall be done by craftsmen skilled in their respective trades. When cutting is required, it shall be done in such a manner as not to weaken walls, partitions, or floors. Holes required to be cut in floors must be drilled without breaking out around the holes. Cutting, patching, and painting shall conform to the requirements of the General Conditions section of this Specification.
- B. Cutting of structural framing, walls, floors, decks, or other members intended to withstand stress is not permitted.
- C. Sleeves through floors or walls shall be black iron pipe and shall be flush with finished faces of floors, walls or ceilings. Sleeves shall be sized to accommodate raceways indicated.
- D. Use care in piercing water proofing. After the part piercing the waterproofing has been set in place, seal openings, and make absolutely watertight.

3.4 SLEEVES

- A. Sleeves through foundation walls or footings shall be avoided, if possible. In the event that multiple sleeves adjacent to each other are required through foundation walls or footings, the size, quantity and location of sleeves shall be provided to the design team (including the Structural Engineer) for review prior to installation.
- B. Sleeves shall be used to accommodate conduit or tubing where conduit or tubing pass through newly poured concrete walls or slabs.
- C. All sleeves through floors and walls shall be black iron pipe, flush with walls or finished floors; and of sizes to accommodate the raceways shown. Sleeves through outside walls above grade shall be caulked with approved caulking compound. Sleeves shall not be required through on grade slabs.
- D. For raceways which enter buildings below grade, install manufactured floor and thruwall seals, similar to Type "FSK" or "WSK" as manufactured by O.Z. Electric Manufacturing Co.

3.5 INSTALLATION METHODS

- A. Conductors shall be installed in concealed raceways except as shown otherwise on the drawings or specified to be otherwise in these specifications. Exposed conduits and wires shall be installed parallel or perpendicular to building surfaces. Conduits and wires in the space above ceilings shall be supported adequately and shall not be laid on the top of ceiling systems. Conduits and wires installed above ceilings shall be considered exposed.
- B. Electrical conduits shall not be hung on hangers with any other service foreign to the electrical systems, nor shall they be attached to other foreign services.
- C. The lighting and power branch circuit conductors shall be installed in separate raceway systems unless specifically shown or noted otherwise.
- D. Equipment Bases. Provide concrete equipment bases for all floor mounted equipment furnished under this contract. Concrete bases shall be 3-1/2"-inches high unless noted otherwise and shall extend 3-inches beyond all sides of the unit. Trowel all edges at a 45 degree angle. This work shall be done in accordance with Division 3 of the specifications by the Division 26 Contractor. Bases shall be provided for switchboards, motor control centers, transformers and all other floor mounted equipment.
- E. Outlet Box Locations. Outlet boxes shall be located so they are not placed back-to-back in the same wall, and in metal stud walls, are separated by at least one stud space in order to limit sound transmission from room to room. Outlet boxes installed on opposite sides of fire rated walls shall be spaced at least 24" apart.

3.6 WIRING - NUMBER OF WIRES REQUIRED

- A. The number of wires for lighting and receptacle branch circuits is shown on the drawings. The number of wires in any circuit is determined in accordance with the National Electrical Code, and wiring is provided to perform all functions of the devices being installed. Additionally, wires shall be provided as required by the contract documents, i.e. equipment grounds, etc. Provide the number of wires required for a complete and workable system.

3.7 PROTECTION FROM WEATHER

- A. Raceway stub ups shall be capped or otherwise protected from moisture and debris until such time that the conductors are pulled. Conductors shall not be installed in raceways until the building is protected from the weather, all concrete and plastering is completed, and raceways in which moisture has collected have been swabbed or blown out.

3.8 ELECTRICAL ROOM COORDINATION

- A. Where a number of electrical panels and/or related electrical items are shown, the Electrical Contractor shall coordinate the physical sizes with his equipment suppliers to ensure that there is adequate space for the items shown to be installed in those areas and that all Code required clearances are maintained.
- B. The Contractor shall rearrange the equipment layout to achieve full use of the available space prior to installing conduit stub ups. Where a conflict or rearrangement exists, the Contractor shall submit a proposed revised layout of the area to the Engineer.

3.9 NAMEPLATES

- A. Nameplates shall be provided for all items such as panelboards, cabinets, motor controllers (starters), safety switches, separately enclosed circuit breakers, individual breakers and controllers in switchboards and motor control centers, control devices and other significant equipment
- B. Nameplates shall be 1"x 2-1/2" laminated black phenolic resin with a white core with engraved lettering, a minimum of 3/16-inch high. Manufacturers factory installed nameplates shall be acceptable provided all information is furnished.
- C. Nameplates shall identify the equipment item that the device is serving and also from where the device is being fed from. Nameplates shall also identify the system voltage of the item of equipment.
- D. Nameplates shall also be provided listing calculated SCCR at the main service distribution equipment and elevator controllers in accordance with NEC requirements.

3.10 RACEWAY SUPPORTS

- A. Raceways shall be securely supported and fastened in place with pipe straps, wall brackets, caddy clips, hangers or trapeze hangers at intervals specified in Section 26 05 33 "RACEWAYS" or:
 - 1. As shown on the drawings.
 - 2. As may be required by special adverse field conditions.
- B. Spring tension clamps on building steel work may be used only by special permission.
- C. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws or welded threaded studs on steel work. Nail-type nylon anchors or threaded studs driven in by a powder charge and provided with lock washers and nuts may be used in lieu of expansion bolts or machine wood screws. Threaded C-clamps shall not be used. Raceways or pipe straps shall not be welded to steel structures. Holes cut in reinforced concrete beams or in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used, and bar hangers may be attached with saddle ties of not less than No. 16 AWG double strand zinc-coated steel wire. No raceway shall be attached to the suspended ceiling construction. Conduits shall be fastened to all sheet-metal boxes and cabinets with two locknuts and insulating bushings.

3.11 BOX SUPPORTS

- A. Boxes and supports shall be fastened to wood with wood screws or screw-type nails of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Plastic expansion shields shall not be used. Threaded studs driven in by powder charge and provided with lockwashers and nuts may be used in lieu of wood screws, expansion shields, or machine screws. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers. Raceways shall be supported with an approved type fastener not more than 24-inches from the box. Penetration into reinforced concrete beams and into reinforced-concrete joists shall avoid cutting any main reinforcing steel.

3.12 LIGHTING FIXTURE SUPPORTS

- A. Lighting fixtures shall be supported as follows and in accordance with all applicable Codes and Regulations:
1. By fixture studs or other devices securely attached to outlet box, or;
 2. By special hangers designed and intended for use as lighting fixture supports, or;
 3. By a special clip or device attached to the ceiling system grid designed to secure the lighting fixture in place or;
 4. By other methods and devices designed and intended for use as lighting fixture support, or;
 5. As shown on the drawings.
 6. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 9 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.
 7. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.
- B. The lighting fixture support system detail shall be submitted with and be a part of the lighting fixture shop drawing submittal.
- C. Lighting fixtures shall not be supported from the leg of pre-cast pre-stressed concrete.
- D. Reference Specification section "23 05 48 – Seismic and Vibration Isolation Controls for HVAC, Plumbing, Fire Suppression, and Electrical Building Systems" for all seismic requirements for electrical and low voltage systems.

END OF SECTION 26 05 01

**SECTION 26 05 19
CONDUCTORS**

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work in this Section.
- B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to conductors.
- C. **Seismic Requirements:**
 - 1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."** for seismic restraint devices and installation.
 - 2. **Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.
 - 3. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Egress Lighting: $I_p = 1.5$**
 - b. **Egress lighting Inverter and circuitry to associated lights: $I_p = 1.5$**
 - c. **Exit signs: $I_p = 1.5$**
 - d. **Fire Alarm System: $I_p = 1.5$.**
 - e. **All other components: $I_p = 1.0$**

1.2 Description of Work: Extent of electrical wire and electrical cable work is indicated by drawings and schedules. Types of wire, cable and connectors in this Section include the following:

- A. Conductors
- B. Power-limited circuit cable
- C. Service entrance cable

1.3 QUALITY ASSURANCE

- A. **Manufacturers:** Firms regularly engaged in the manufacture of electric wire and cable products of types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Installer: Qualified with at least 3 years of successful installation experience on projects with electrical wiring work similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wire, cable and connectors.
- B. UL Compliance: Comply with UL standards pertaining to wire cable and connectors.
- C. UL Labels: Provide electrical wires, cables and connectors which have been UL-listed and labeled.
- D. NEMA/ICEA Compliance: Comply with applicable portions of NEMA/Insulated Cable Engineers Association Standards pertaining to materials, construction and testing of wire and cable.
- E. ANSI/ASTM: Comply with applicable portions of ANSI/ASTM standards pertaining to construction of wire and cable.
- F. IEEE Compliance: Comply with applicable portions of IEEE standards pertaining to wire and cable.
- G. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

- A. Submit manufacturer's data on electric wire and cable.

2. PRODUCTS

- 2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of wire, cable and connector):

- A. WIRE AND CABLE:

- 1. Advance Wire and Cable, Inc.
 - 2. Cerro Wire and Cable, Co.
 - 3. Electrical Conductors, Inc.
 - 4. General Cable Corp.
 - 5. Hitemp Wires, Inc.
 - 6. Rome Cable Corp.
 - 7. Southwire Company
 - 8. The Okonite Company
 - 9. Encore Wire

- B. CONNECTORS:

- 1. Amp, Inc.
 - 2. Burndy Corp.
 - 3. Eagle Electric Mfg. Co., Inc.
 - 4. Gould, Inc.

5. Ideal Industries, Inc.
6. Joselyn Mfg. and Supply Co.
7. O-Z/Gedney Co.
8. Pyle National Co.
9. Thomas and Betts Co.

2.2 WIRE, CABLE, AND CONNECTORS

- A. General: Except as otherwise indicated, provide wire, cable and connectors of manufacturer's standard materials, as indicated by published product information; designed and constructed as recommended by manufacturer, and as required for the installation.

B. WIRE:

1. All conductors shall be 600-volt and shall be copper, soft drawn, annealed, having a conductivity of not less than 98% pure copper with dual rated type THHN/THWN insulation unless otherwise specified or indicated on the drawings.
2. No wire shall be smaller than No. 12 AWG, except wiring for signal and pilot control circuits, and pre-manufactured fixture whips for light fixtures.
3. All wire No. 12 AWG shall be solid unless otherwise indicated within these specifications. All wire No. 10 AWG and larger shall be stranded.
4. All wiring installed in light poles or other areas subject to vibration shall be stranded.
5. Wire sizes shown are minimum based on code requirements, voltage drop and/or other considerations. Larger sizes may be installed at the Contractor's option to utilize stock size, provided conduit sizes are increased where necessary to conform to the National Electrical Code. Sizes of wires and cables indicated or specified are American Wire Gage (Brown and Sharpe).
6. All feeder and branch circuit wiring shall be color-coded as follows:

<u>PHASE</u>	<u>120/208 VOLT</u>	<u>277/480 VOLT</u>
A	Black	Brown
B	Red	Orange
C	Blue	Yellow
Neutral	*White	*White
Ground	Green	Green

*Except as provided in paragraph 200.6 of the NEC.

C. ALUMINUM WIRE:

1. Aluminum conductors shall not be substituted for copper conductors.

D. CONNECTIONS

1. Wire connections shall be as follows unless otherwise indicated on the drawings.
 - a. Use preinsulated connectors 3M Company "Scotchlok," or Ideal Industries, Inc. "super nut," for splices and taps in conductors No. 10 AWG and smaller. All other twist-on connectors must be reviewed by the Architect prior to installation. Use this type of connector for factory-made splices in fixtures or equipment.
 - b. Pressure indent type connectors must be submitted to the Architect for review.

- c. Tape all splices and joints with vinyl plastic tape manufactured by Minnesota Mining and Manufacturing Company. Use sufficient tape to secure insulation strength equal to that of the conductors joined.
- d. Keep splices in underground junction boxes to an absolute minimum. Where splices are necessary, use resin pressure splices and resin splicing kits manufactured by the 3M Company, St. Paul, Minnesota, to totally encapsulate the splice. Arrange the splicing kit to minimize the effects of moisture.
- e. Connect wire No. 6 AWG and larger to panels and apparatus by means of approved lugs or connectors.
- f. Connect wire No. 10 AWG and larger to panels, motors and electrical apparatus using OZ (or equivalent) type XL set screw type lugs. Lugs shall accommodate full wire capacity for stranded conductors. All connections and connectors shall be solderless.
- g. Connectors of the porcelain cup type with or without metal inserts shall not be used, including all splices in fixtures which are made in advance by the fixture manufacturer. Splices in wire No. 8 AWG and larger shall be made with approved solderless lugs. If any type of pressure indent type connector is proposed for use on any size conductor, it shall be specifically submitted for approval prior to use.

3. EXECUTION

3.1 INSTALLATION

- A. General: Install electric cables, wires and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.
- B. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.
- C. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized wherever required.
- D. Splicing: No splicing or joints will be permitted in either feeder or branch circuits except at outlet or accessible junction boxes.
- E. Wire shall not be installed in raceways until the concrete work and plastering is completed and all conduits in which moisture has collected have been swabbed out. Insulation resistance to ground shall not be less than that approved by NEC. Eliminate splices wherever possible.
- F. Use pulling compound or lubricant where necessary. Compound must not deteriorate conductor insulation.
- G. Prior to energization, check cable and wire for continuity of circuitry, and for short circuits. Correct malfunctions when detected.
- H. Bury a continuous, pre-printed, bright colored plastic ribbon cable marker with each underground cable, regardless of whether conductors are in conduit. Locate each directly over cables 12" below finished grade.
- I. Conductor Installation: Install all conductors in a single raceway at one time, insuring that conductors do not cross one another while being pulled into raceway. Leave sufficient cable at

all fittings or boxes and prevent conductor kinks. Keep all conductors within the allowable tension and exceeding the minimum bending radius.

- J. Conductor Support: Provide conductor supports as required by the code and recommended by the cable manufacturer. Where required, provide cable supports in vertical conduits similar to OZ Type C.M.T., and provide the lower end of conduit with OZ Type KVF ventilators.
- K. Conductor Termination: Provide all power and control conductors, that terminate on equipment or terminal strips, with solderless lugs or fork and flanged tongue terminals. Provide T and B "sta-kon" tongue terminal. This type conductor termination is not required when the equipment is provided with solderless connectors.
- L. **Many circuits are shown on the drawings to be provided with dedicated neutral and ground conductors. Carefully review circuiting and the electrical abbreviations and symbols legend and provide the number of conductors indicated.**
- M. **Unless otherwise indicated provide dedicated neutral conductors for all branch circuits. Neutral conductors shall not be shared between circuits. Where the drawings indicate shared neutral conductors, for a multi-wire branch circuit, group the breakers together in accordance with NEC requirements.**

3.2 CONDUCTOR ARCPROOFING

- A. Cover two or more power feeder cables occurring in the same switchboard section, junction box or pull box (including pull boxes over switchboards) with arcproof and flameproof tape.
- B. Provide 3M Company "Scotch" No. 77 tape or Plymouth Rubber Co. Slipknot No. 30 tape, to provide an installation capable of withstanding a 200-amp arc for not less than 30 seconds.
- C. Apply tape in a single layer, one-half lapped, or as recommended by the manufacturer to conform to the above requirements. Apply with the coated side next to the cable and hold in place with a random wrap of 1/2 inch wide, pressure-sensitive, glass cloth electrical tape, 3M Company "Scotch" No. 69. Tape to be color coded as specified previously.

END OF SECTION 26 05 19

SECTION 26 05 26
GROUNDING SYSTEM

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.
- B. Division 26 "Basic Materials and Methods" sections apply to work of this Section.
- C. Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.

1.2 DESCRIPTION OF WORK

- A. Extent of grounding work is indicated by the drawings and is specified herein.
- B. Applications of grounding work in this Section include the following:
 - 1. Underground Metal Piping
 - 2. Underground Metal Water Piping
 - 3. Metal Building Frames
 - 4. Ground Rods
 - 5. Separately Derived Systems
 - 6. Service Equipment
 - 7. Enclosures
 - 8. Equipment
- C. Requirements of this Section apply to electrical grounding work specified elsewhere in these specifications.

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of electrical connectors, terminals and fittings, of types and ratings required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods and plate electrodes, whose products have been of satisfactory use in similar service for not less than three years.
- B. Installer: Qualified with at least three (3) years experience on projects with electrical grounding work similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring. Provide grounding products which are UL listed and labeled.

- B. UL Compliance: Comply with applicable requirements of UL Standard Nos. 467 and 869 pertaining to electrical grounding and bonding.
- C. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical grounding.
- D. Utility: Grounding shall be done so as to comply with all applicable grounding requirements and rules of the serving utility.
- E. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

- A. Product Data: Submit manufacturers data on grounding systems and accessories.
- B. Shop Drawings: Submit layout drawings of grounding systems and accessories including, but not limited to, ground wiring, copper braid and bus, and ground rods.

2. PRODUCTS

2.1 Acceptable Manufacturers: Subject to compliance with the requirements, provide grounding products of one of the following:

- A. B-Line Systems
- B. Burndy Corporation
- C. Crouse Hinds
- D. Electrical Components Div.; Gould Inc.
- E. General Electric Supply Co.
- F. Ideal Industries, Inc.
- G. Thomas and Betts Corp.
- H. Western Electric Co.

2.2 Grounding Systems: Except as otherwise indicated, provide electrical grounding systems indicated; with assembly of materials, including but not limited to cables/wires, connectors, terminals, ground rods/electrodes, bonding jumper braid, and additional accessories needed for a complete installation. Where more than one type unit meets indicated requirements, selection is installer's option. Where materials or components are not indicated, provide products complying with NEC, UL, IEEE and established industry standards for applications indicated.

2.3 Conductors: Unless otherwise indicated, provide electrical grounding conductors for grounding connections matching power supply wiring materials and sized according to NEC requirements.

- 2.4 Bonding Jumper Braid: Provide copper braid tape, constructed of 30 gage bare copper wires and properly sized for indicated applications.
- 2.5 Flexible Jumper Strap: Provide flexible flat conductor, 480 strands of 30 gage bare copper wire; 3/4" wide, 9-1/2" long; 48,250 cmil. Protect braid with copper bolt hole ends with hole sized for 3/8" dia. bolts.
- 2.6 Bonding Plates, Connectors, Terminals and Clamps: Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by bonding plate, connector, terminal and clamp manufacturers for indicated applications.
- 2.7 Ground Rods: Provide steel ground rods with copper welded exterior, 3/4" dia. x 10'.
- 2.8 Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended by accessories manufacturers for types of service indicated.

3. EXECUTION

3.1 GENERAL

- A. Inspection: Installer must examine areas and conditions under which electrical grounding connections are to be made and notify the Architect/Engineer in writing of conditions detrimental to proper completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.
- B. General: Install electrical ground systems where shown, in accordance with applicable portions of the NEC, with NECA's "Standard of Installation", and in accordance with recognized industry practices to ensure that products comply with requirements and serve intended functions.
- C. Coordinate with other electrical work as necessary to interface installation of electrical grounding systems with other work.
- D. Grounding and bonding of electrical installations and specific requirements for systems, circuits and equipment required to be grounded shall be accomplished for temporary and permanent construction.
- E. Provide a separate green equipment ground conductor in all electrical raceways to effectively ground all fixtures, panels, receptacles, controls, motors, disconnect switches, exterior lighting standards and noncurrent carrying metal enclosures. The ground wires shall be connected to the building system ground. NEC Table 250.122 shall be used to size the ground conductor if the size is not shown on the drawings.
- F. To satisfy the "effective grounding" requirements of the NEC the path to ground from circuits, equipment, and conductor enclosures shall be permanent and continuous and shall have ample carrying capacity to conduct safely any currents liable to be imposed on it, and shall have

impedance sufficiently low to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit.

- G. Ground the service in accordance with provisions of the National Electrical Code and the contract drawings.
- H. In addition to the requirements for service entrance grounding listed above, provide a supplemental grounding electrode consisting of driven ground rods (three 10 foot x 3/4 inch copper-clad steel ground rods).
- I. Clean the contact surfaces of all ground connections.
- J. Where separately derived systems occur, ground the system to a grounding electrode acceptable to the code.
- K. Install metallic raceways mechanically and electrically secure at all joints and at all boxes, cabinets, fittings and equipment. At the point of electrical service entrance, bond all metallic raceways together, with a ground conductor, and connect to the system ground bus. Bond all boxes as specified for equipment.
- L. Receptacles: Permanently connect the ground terminal on each receptacle to the green ground conductor.
- M. Motors: Connect the ground conductor to the conduit with an approved grounding bushing, and to the metal frame with a bolted, solderless lug.
- N. Provide necessary ground connections to telephone service entrance equipment. Verify requirements with the local telephone company and/or Owner.

END OF SECTION 26 05 26

**SECTION 26 05 33
RACEWAYS**

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.
- B. This Section is a Division 26 "Basic Materials and Methods" section, and is part of each Division 26 section making reference to electrical raceways specified herein.
- C. **Seismic Requirements:**
 - 1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems."** for seismic restraint devices and installation.
 - 2. **Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.
 - 3. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Egress Lighting: $I_p = 1.5$**
 - b. **Egress lighting Inverter and circuitry to associated lights: $I_p = 1.5$**
 - c. **Exit signs: $I_p = 1.5$**
 - d. **Fire Alarm System: $I_p = 1.5$.**
 - e. **All other components: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. Extent of raceways is indicated by drawings and schedules.
- B. Types of raceways in this Section include the following:
 - 1. Electrical metallic tubing.
 - 2. Flexible metal conduit.
 - 3. Intermediate metal conduit.
 - 4. Liquid-tight flexible metal conduit.
 - 5. Rigid metal conduit.
 - 6. Rigid nonmetallic conduit.
 - 7. Surface metal raceways.

1.3 REFERENCES

- A. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- B. UL Compliance and Labeling: Comply with provisions of UL safety standards pertaining to electrical raceway systems; and provide products and components which have been UL-listed and labeled. Each length of raceway shall bear the Underwriters Laboratories label.
- C. NEC Compliance: Comply with NEC requirements which are applicable to the construction and installation of raceway systems.
- D. NECA Compliance: Comply with NECA's "Standard of Installation".

1.4 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations, for each type of raceway required.

2. PRODUCTS

2.1 STEEL CONDUIT

- A. Steel Conduit: Rigid steel conduit, intermediate metal conduit and steel electrical metallic tubing shall be hot-dipped, galvanized or sheradized as manufactured by Youngstown Sheet and Tube Company, National Electric, General Electric, or equal.
- B. Joints: Raintight non-insulated throat type compression fittings (connectors and couplings) shall be provided for electrical metallic tubing systems. All fittings shall be of the steel type with steel locknuts equal to Appleton 95 Series.
- C. Expansion Joints: Provide expansion fittings, O.Z. Type AX with bonding jumper for rigid conduit and O.Z. Type TX with bonding jumper for electrical metallic tubing. Where embedded raceways cross building expansion joints, provide combination deflection/expansion fittings, O.Z. Type AXDX, or equal.

2.2 RIGID NON-METALLIC (PVC) CONDUIT

- A. PVC (polyvinyl chloride) Conduit: Heavy wall rigid PVC conduit shall be composed of high impact PVC and shall conform to industry NEMA Standards and to Federal Specification WC-1094. Conduits shall be Carlon Schedule 40 type, or approved equal.

2.3 FLEXIBLE METAL CONDUIT

- A. Flexible metal conduit shall conform to UL1. It shall be formed from continuous length of spirally-wound, interlocked zinc-coated strip steel.
- B. **Pre-wired armored cabling, types AC or MC are not allowed.**

2.4 LIQUID-TIGHT, FLEXIBLE METAL CONDUIT

- A. Liquid-tight flexible metal conduit shall be constructed of a single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; and coated with an oil-resistant, liquid-tight thermoplastic jacket.

2.5 WIREWAYS

- A. General: Provide electrical wireways of types, grades, sizes, weights (wall thicknesses), and number of channels for each type service indicated. Provide complete assembly of wireways including, but not necessarily limited to couplings, offsets, elbows, expansion joints, adapters, hold down straps, end caps, and other components and accessories as needed for a complete system. Where types and grades are not indicated, provide proper selection as determined by the Installer to fulfill wiring requirements and comply with applicable provisions of NEC for electrical raceways.
- B. Surface Metal Raceways: Provide surface metal raceways of sizes and channels indicated; in compliance with FS W-C-582. Construct of galvanized steel with snap-on covers, with 1/8" mounting screw knockouts in base approximately 8" o.c. Provide fittings indicated which match and mate with raceway. Finish with manufacturer's standard prime coating suitable for painting. Provide all necessary devices as shown on the drawings for a complete installation.
- C. Manufacturers: Subject to compliance with requirements, provide surface metal raceways of one of the following:
 - 1. B-Line Systems, Inc.
 - 2. Midland-Ross Corporation
 - 3. Power-Strut Division; Youngstown Sheet and Tube Company
 - 4. Square D Company
 - 5. Versa-Tech Corporation
 - 6. Walker/Parkersburg Division; Textron, Inc.
 - 7. Wiremold Company

3. EXECUTION

3.1 GENERAL

- A. Install electric raceways where indicated; in accordance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation" and complying with recognized industry practices.
- B. Raceways embedded in concrete or in earth below floor slabs shall be rigid steel conduit, intermediate metal conduit or rigid schedule 40 PVC conduit. Rigid PVC conduit shall be provided with rigid metal or intermediate metal conduit elbows when the raceway system exits the concrete topping or earth.
- C. Electrical metallic tubing shall not be embedded in concrete or installed in earth.
- D. Rigid heavy wall Schedule 40 PVC conduit shall be installed in earth and concrete only.
- E. Raceways in outside walls (excluding building perimeter) or in refrigerated areas shall be rigid steel conduit, or intermediate metal conduit.

- F. Provide rigid steel conduit or intermediate metal conduit for exposed raceways from floor to eight feet above the floor in mechanical rooms and in areas designated on the plans.
- G. Rigid galvanized steel conduit or galvanized intermediate metal conduit shall be used where conduit is exposed to weather.
- H. Conduits in hazardous locations shall conform to the National Electrical Code. Rigid galvanized steel conduit or intermediate metal conduit shall be used in hazardous locations. PVC conduit shall not be used in hazardous areas.
- I. Rigid metal, intermediate metal, electric metallic tubing or PVC conduit where allowed in other section 3.1 paragraphs shall be used for feeders and branch circuits.
- J. Flexible metal conduit may be used to connect light fixtures in accordance with NEC requirements but must be limited to a maximum of 6'-0" in length. "Daisy chaining" from fixture to fixture is not permitted. Provide flexible metal conduit for connections to motors, transformers, generators, and other equipment subject to vibration. Length of flexible conduit shall be a minimum of one foot for conduit diameters up to 1-1/2". A minimum of 3" of flexible conduit shall be added for every 1/2" increase in conduit diameter. Flexible metal conduit installation shall be kept to a minimum in connecting other electrical equipment items. Sealtight, flexible conduit shall be used where the flexible conduit may be subject to moist or humid atmosphere, corrosive atmosphere, subject to water spray and subject to dripping oil, grease or water. **Flexible metal conduits shall not be permitted for any other applications, unless specifically approved by the Owner**
- K. Conduits shall be 3/4" diameter, minimum. Raceway sizes shown on the drawing are based on type THHN/THWN conductors.
- L. Type Material: Except as noted otherwise all conduit shall be steel.

3.2 INSTALLATION

- A. All raceways shall be installed concealed except where shown or noted otherwise.
- B. At the Owner's option, concealed raceways may be embedded in concrete or routed below the slab. At the Contractor's option, concealed raceways may be installed in furred spaces above ceilings or behind walls.
- C. Continuity: Provide metallic raceways continuous from outlet to outlet, and from outlets to cabinets, junction or pull boxes. Enter and secure conduit to all boxes to provide electrical continuity from the point of service to outlets. Provide double locknut and bushing on terminals of metallic conduits.
- D. A nylon or polypropylene pull string shall be installed in all empty conduits to facilitate future installation of cabling.
- E. Provide accessible "seal-off" fittings for all raceways entering or leaving any hazardous areas, entering or leaving refrigerated areas and as otherwise required by the National Electrical Code.
- F. Where conduits penetrate the roof seal, they shall be installed in curbs provided for mechanical equipment. When this is not possible, suitable pitch pockets, lead flashing, or approved fittings shall be provided. Details for special conduit installations shall be as shown on the drawings.

- G. Reinforced Concrete: No reinforcing steel shall be displaced to accommodate the installation of raceways and outlet boxes. Outlet boxes shall not be installed in beams or joists. In general, all embedded conduits shall be located in the physical center of the particular section of concrete. Unless otherwise indicated, raceways embedded in reinforced concrete shall conform to the following usual types of conditions. Particular attention is called to the fact that there are many extenuating conditions where the Contractor may be instructed in writing during the course of the project not to place embedded conduits in certain areas, generally due to the possibility of unsightly cracking or for structural reasons. This instruction shall not entitle the Contractor to extra compensation. Any condition not covered by the following usual conditions shall require special clarification.

<u>Location</u>	<u>Maximum Allowance</u>
1. Columns	Displacement of 4 percent of plan area of column.
2. Floors and Walls	Displacement of 1/3 of thickness of concrete spaced not less than three diameters on center.
3. Beams and Joists	Displacement of 1/3 of least dimension, spaced not less than three diameters on center.
4. Sleeves thru Floors and Walls	2" maximum pipe size, not less than three diameters on center.

- H. Plain Concrete: Raceways shall not be placed in plain concrete, such as cement toppings on structural floors without special instructions.
- I. Furred Spaces: Raceways installed in furred spaces shall be installed in accordance with the requirements of the National Electrical Code. Do not anchor or strap conduits to the ceiling furring channels or attach to furred ceiling hanger wires. Raceways may be attached to the suspension system (wire hangers) of drop ceilings if installed in such a manner that the ceiling panels may be removed without interference with the raceway, and the wire hangers are sized to carry the additional raceway load.
- J. Stub Ups: Extend conduit stubs at least one foot above slab or fill, before connection is made to electrical metallic tubing.
- K. Exterior Conduits: Install raceways a minimum of 42" below finished grade unless noted otherwise on the drawings.
- L. Provide marking of conduit and junction boxes to indicate which distribution system they are serving. The markings could be colored tape on conduit at or near junction boxes with different colored tapes indicating different distribution systems. Concealed junction boxes shall be legibly marked with a magic marker to indicate the panel and circuit number that junction box serves.
1. The distribution systems shall be color coded as follows:
 - a. Fire Alarm - Red
 - b. Nurse Call - Yellow
 - c. Paging System - Blue
 - d. 120/208 Volt - Green
 - e. 277/480 Volt - Orange
 - f. Cable TV System - Black
 - g. Telephone System - White

M. Steel Conduit (galvanized rigid steel, IMC or EMT):

1. Cutting: Cutting shall be done with hand or power hacksaws. All cut ends shall be reamed to remove burrs and sharp edges.
2. All threaded joints shall be made up wrench-tight and all compression joints shall be made up mechanically secure and snug so as to make continuous current-carrying electrical contact.
3. All metallic conduits buried or otherwise in contact with earth shall be painted using one heavy continuous coat of asphalt varnish after assembly of conduit and fittings.
4. Expansion joints shall be installed in steel conduit systems in structures as follows (expansion joints are specified elsewhere in the specification):
 - a. Where conduit run crosses a building expansion joint.
 - b. In any conduit run exceeding 100 feet in length.
 - c. Where shown on the drawings.

N. Threads: Clean all threads of rigid or intermediate metal conduit. Coat all male threads of all steel conduit installed in concrete with red or white lead immediately before being coupled together.

O. Running Threads: Use "Erickson" type couplings in lieu of running threads.

P. PVC Conduit:

1. Joints: Conduits shall be joined by using couplings and solvent cement furnished or recommended by the raceway manufacturer. Finished joints shall be secure and watertight.
2. Cutting: Cutting shall be done with hacksaws and ends shall be reamed to remove burrs and sharp edges.
3. Expansion Joints: Expansion joints shall be installed:
 - a. Where conduit run crosses a building expansion joint.
 - b. As recommended by the manufacturer or as shown on the drawings.
4. Bends for PVC conduit sizes 2" and smaller may be made "hot" in the field. Inside dimension shall be thereby undistorted. For PVC sizes larger than 2", provide only factory bends.

END OF SECTION 26 05 33

**SECTION 26 22 00
DRY-TYPE TRANSFORMERS**

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this Section.
- B. **Seismic Requirements:**
 - 1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
 - 2. **Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. **The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.**
 - 3. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Dry-type transformers: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. Extent of transformer work is indicated by drawings and schedules.
- B. Types of transformers specified in this Section include the following:
 - 1. Energy Efficient Dry-type Transformers
 - 2. Shielded, Isolation Type Transformers
- C. Refer to other Division 26 sections for electrical wiring connections required in conjunction with transformers; not work of this Section.

1.3 QUALITY ASSURANCE

- A. **Manufacturers:** Firms regularly engaged in the manufacture of power distribution transformers of types and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. **Installer:** Qualified with at least three (3) years successful installation experience on projects with electrical power/distribution transformer work similar to that required for this project.

1.4 REFERENCES

- A. **NEC Compliance:** Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.

- B. NEMA Compliance: Comply with applicable portions of the NEMA Std. Pub. Nos. TR1 and TR27 pertaining to power/distribution transformers.
- C. ANSI Compliance: Comply with applicable ANSI standards pertaining to power/distribution transformers.
- D. ANSI/IEEE Compliance: Comply with applicable ANSI/IEEE standards pertaining to power/distribution transformers..
- E. ANSI/NEMA Compliance: Comply with NEMA Std. ST 20 "Dry-Type Transformers for General Applications".
- F. ANSI/UL Compliance: Comply with applicable portions of ANSI/UL 506 "Safety Standard for Specialty Transformers".
- G. UL Labels: Provide distribution transformers that have been UL listed and labeled.
- H. IECC Compliance: Transformers shall be fully compliant with provisions of the International Energy Conservation Code, 2018 Edition.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data including KVA rating, frequency, primary and secondary voltages, percent taps, impedance and certification of transformer performance efficiency at indicated loads, no load and full load losses in watts, hot spot and average temperature rise above 40 degrees C ambient, sound level in decibels, and standard published data.
- B. Shop Drawings: Submit manufacturer's drawings indicating dimensions and weight loading for transformer installations.

2. PRODUCTS

2.1 Manufacturers: Subject to compliance with requirements, provide products of one of the following (for each type of transformer):

- A. Cutler Hammer
- B. General Electric Co.
- C. Square D Co.
- D. Siemens

2.2 EQUIPMENT

2.3 Furnish and install dry-type transformers as shown on the drawings.

- A. Transformer coils shall be of the continuous **copper wound construction**.
- B. All transformer cores shall be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

- C. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
- D. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.
- E. Dry-type transformers shall have metallic enclosures designed to provide for air cooling and to prevent accidental contact with live conductors. Materials and final performance of the product must conform to applicable IEEE and NEMA standards. Transformer wiring compartment shall be located below the core and coil, and shall be cooled by air circulation, or the wiring compartment shall be insulated from the core and coil by means of a suitable thermal insulation barrier. All transformers shall be UL listed and shall bear the UL label.
- F. Transformers shall operate at 100% nameplate KVA rating continuously while in a 40 degrees C ambient environment without exceeding the rated average winding temperature rise of the ANSI insulated system used. Specific KVA and voltage ratings required shall be as shown on the drawings. Transformers rated above 30 KVA shall have a 220 degrees C insulation system with 150 degrees C average temperature rise or 180 degrees C hot spot rise in a 40 degrees C ambient. Transformers rated 30 KVA and below shall have a 180 degrees C insulation system with 115 degrees C average temperature rise or 145 degrees C hot spot rise in a 40 degrees C ambient.
- G. Sound levels must fall within ANSI-NEMA Standard levels according to KVA size.
- H. Sound levels shall be warranted by the manufacturer not to exceed the following:
 - 1. 15 to 50KVA - 45dB; 51 to 150kVA - 50dB; 151 to 300kVA - 55dB; 301 to 500kVA - 60dB; 501 to 700kVA - 62dB; 701 to 1000kVA - 64dB; 1001 to 1500kVA - 65dB; 1501 to 2000kVA - 66Db.
- I. All transformers shall be supplied with clamp-type solderless connectors suitable for use with copper connecting cables.
- J. All transformers shall have neoprene rubber pads between the core and coil assembly and the transformer enclosure to isolate sound and vibration. A flexible conduit connection to the transformer may be used.
- K. Terminal boards shall be provided on all transformers. High-voltage and low-voltage terminals must be held in a fixed position, thus removing any need for taping of cable-terminal connections.
- L. Transformers which weigh more than 50 pounds must have external lifting provisions for ease in handling.
- M. Single phase transformers over 10 KVA and three-phase transformers 6 KVA and above shall have minimum full load rated taps in the high-voltage windings as follows: four 2-1/2% full capacity taps, 2 above and 2 below normal rated voltage. Transformer taps shall be adjusted to deliver nominal system voltage at branch circuit panels.

3. EXECUTION

- 3.1 Install transformers as indicated in compliance with the manufacturers' written instructions, applicable requirements of the NEC, NEMA, ANSI and IEEE standards, and in accordance with recognized industry practices to ensure that products fulfill requirements.
- 3.2 Coordinate transformer installation work with electrical raceway and wire/cable work, as necessary for proper interface.
- 3.3 Install transformers on vibration mounts; comply with manufacturers recommended installation methods, if applicable.
- 3.4 Clearances shall be maintained around transformers in accordance with all applicable codes, standards and manufacturer's installation instructions.

END OF SECTION 26 22 00

**SECTION 26 24 16
PANELBOARDS**

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including General and Supplementary Conditions and Division 1 specification sections, apply to the work of this Section.
- B. This Section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 26 section making reference to panelboards specified herein.
- C. **Seismic Requirements:**
 - 1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
 - 2. **Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. **The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.**
 - 3. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Panelboards: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. Extent of panelboard and enclosure work, including cabinets and cutout boxes is indicated on the drawings and by schedules.
- B. Types of panelboards and enclosures in this Section include the following:
 - 1. Distribution Panels
 - 2. Lighting and Appliance Panels
 - 3. Transient Voltage Surge Suppression (TVSS) Panels
- C. Refer to other Division 26 sections for cable/wire, connectors and electric raceway work required in conjunction with panelboards and enclosures; not work of this Section.

1.3 QUALITY ASSURANCE

- A. **Manufacturers:** Firms regularly engaged in the manufacture of panelboards and enclosures, of types, size and ratings required, whose products have been in satisfactory use in similar service for not less than five (5) years.

- B. Installer: A firm of at least three (3) years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

- A. Special Use Markings: Provide panelboards, constructed for special use, with UL markings indicating that special type usage. Panels identified or shown on the drawings for use as main service entrance equipment shall be labeled at the factory with "SERVICE ENTRANCE" type UL label.
- B. UL Compliance: Comply with applicable UL safety standards pertaining to panelboards, accessories, and enclosures. Provide units which have been UL listed and labeled. UL standards are as follows:
 - 1. Panelboards - UL67
 - 2. Cabinets and Boxes - UL50
- C. NEC Compliance: Comply with the NEC as applicable to the installation of panelboards, cabinets, and cutout boxes.
- D. NEMA Compliance: Comply with NEMA Stds. Pub. No. 250 "Enclosures for Electrical Equipment (1000 volt maximum)", Pub. No. 1 "Panelboards" and Pub. No. PB1.1, "Instruction for Safe Installation, Operation, and Maintenance of Panelboards Rates 600 Volts and Less".
- E. NECA Compliance: Comply with NECA's "Standard of Installation".

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's data including specifications, installation instructions and general recommendations for each panelboard required. Include data substantiating that units comply with specified requirements.
- B. Shop Drawings: Submit dimensioned drawings of panelboards and enclosures showing accurately scaled layouts of enclosures and required individual panelboard devices, including but not limited to circuit breakers, fusible switches, fuses, ground fault circuit interrupters, and accessories.
- C. **Shop Drawings shall be submitted along with, and at the same time as the Coordination Study and Arc Flash Hazard Analysis study described in specification section 260500. All submitted section 262416 equipment shall match the equipment in the Coordination Study and Arc Flash Hazard Analysis study.**

2. PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements provide products of one of the following:
 - 1. Square D Company
 - 2. ABB
 - 3. Cutler Hammer

4. Siemens

2.2 GENERAL

- A. Except as otherwise indicated, provide panelboards, enclosures and ancillary components, of types, sizes, and ratings indicated, which comply with manufacturer's standard materials, and which are designed and constructed in accordance with published product information. Provide solderless lugs, or connectors, in the correct number and size for conductors on mains, on the load side of each branch, circuit, and on ground and neutral bars. Provide tin plated copper busses. Provide an insulated neutral bus and a bonded equipment ground bus mounted at the opposite end of the structure from the mains, and having numbered screw or lug terminals for connection of wires. Equip panels with the number of unit devices as required for a complete installation. Where more than one type of component meets the indicated requirements, selection is installer's option. Where types, sizes or ratings are not indicated, comply with NEC, UL and established industry standards for applications indicated.
- B. Provide ground fault circuit interrupting type circuit breakers for all devices noted with a "GFI" subscript on the panelboard schedules for this project.
- C. Provide UL listed HACR type circuit breakers for all devices which serve heating, ventilating, or air conditioning equipment.
- D. Panelboards shall be provided with covers for surface or flush mounting as shown on the drawings, or as required for actual project conditions.
- E. Panelboards shall be constructed for top or bottom feeder service, as required by actual project conditions.

2.3 LIGHTING AND APPLIANCE PANELS

- A. Lighting and appliance panelboards shall be Square D type NF (or equal) for 277/480 volt or Square D type NQOB (or equal) 120/208 volt applications. All branch circuit breakers are to be quick-make, quick-break, trip indicating and common trip on all multi-pole breakers, and shall be bolt-on type. Trip indication shall be clearly shown by breaker handle located between the "ON" and the "OFF" positions. Panelboards shall have distributed phase copper bussing throughout.
- B. **Review drawings and provide main circuit breaker type panels where indicated on the drawings. Additionally, provide main lug only type panels where indicated on the drawings.**
- C. Provide fully rated main circuit breaker or main lug only (see drawings) type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings.
- D. Lighting and appliance panels shall be 5.75" deep, maximum and shall have 6-inch minimum gutters. Fronts are to be complete with door and cylinder lock, with all locks keyed alike. Fronts shall have adjustable trim clamps, directory frames, and shall be equipped with a typewritten directory that identifies each circuit breaker by number and the equipment that the breaker serves. One additional blank directory card for each panel shall be furnished to the Owner.
- E. Two section panels (as required by Code) shall be equipped with boxes of equal dimensions.

- F. Panelboards shall be Underwriters' Laboratory listed and shall bear the UL label. The size of the panelboard main disconnect device or main lugs, the rating and number of branch circuits, and the type of mounting shall be as shown on the drawings.
- G. All factory installed devices shall be re-torqued prior to energizing.

2.4 DISTRIBUTION PANELS

- A. Distribution panels shall be Square D I-Line (or equal) panels as indicated on the plans. Provide appropriate type of panels to meet specific project requirements. Panelboards shall have distributed phase copper bussing throughout.
- B. Circuit breakers shall be as specified for lighting panels unless indicated otherwise. Power panels shall have combination card holder and name-plate and shall be equipped with typewritten directories that identify all loads served and all spare circuits. Provide a copper ground bus in all power panels.
- C. Power panels shall be Underwriters' Laboratory approved and shall bear the UL label. Main lugs and gutters shall be suitable for copper and aluminum wire. The size of the panelboard main protective device or main lugs, the size, type and the number of branch circuits and the type of mounting shall be as shown on the drawings.
- D. **Review drawings and provide main circuit breaker type panels where indicated on the drawings. Additionally, provide main lug only type panels where indicated on the drawings.**
- E. Provide fully rated main circuit breaker or main lug only (see drawings) type panelboards where the short circuit rating of the complete panelboard assembly is determined by the lowest rated branch device. Provide panelboard interrupting ratings as noted on the drawings.

2.5 FEEDER PROTECTIVE DEVICES

- 1. The following paragraphs list the general feeder protective device requirements.
 - a. Feeder protective devices as shown shall be molded case air circuit breakers, built, tested and UL labeled per UL 489.
 - b. In general 100 ampere through 400-ampere frames shall be thermal-magnetic trip with inverse time current characteristics. Breakers with 225 ampere through 400-ampere frames shall have continuously adjustable magnetic pick-ups of approximately five to ten times trip rating.
 - c. In general breakers with 600 ampere frames and above shall be Square D Powerpact or approved equivalent with solid-state trip complete with built in current transformers, solid-state trip unit and flux transfer shunt trip. Breakers shall have easily changed trip-rating plugs with trip ratings as indicated on the drawings. Rating plugs shall be interlocked so they are not interchangeable between frames and interlocked such that breakers cannot be latched with rating plug removed. Breaker shall have built-in test points for testing long delay, instantaneous and ground fault (where shown). Functions of the breaker shall be tested by means of a 120 volt operated test kit. Provide one test kit capable of testing all breakers 600 ampere and above.

- d. Solid state instantaneous element shall be continuously adjustable from approximately 4 to 8 times the trip rating, with short time adjustment from instantaneous to 10-cycle delay for coordination purposes. Provide short delay override feature providing for instantaneous tripping on high magnitude faults.
- e. Molded case breakers shall have a minimum UL listed interrupting capacity as listed on the drawings.
- f. For all circuit breakers rated 1200 Amps or more, provide circuit breaker with an energy reducing maintenance switch per NEC paragraph 240.87

2.6 CUSTOMER METERING

- A. Where indicated on the drawings, provide digital electronic power meters with the following monitoring and metering capabilities:
 - 1. Current, per phase and neutral.
 - 2. Voltage, phase-to-phase and phase-to neutral.
 - 3. Real power (kW), per phase and three-phase total.
 - 4. Reactive power (kVAR), per phase and three phase total.
 - 5. Apparent power (kVA), per phase and three phase total.
 - 6. Power factor (true), per phase and three phase total.
 - 7. Frequency.
 - 8. Demand current, per phase and neutral, present and peak.
 - 9. Real power demand (kWd), three phase total, present and peak.
 - 10. Reactive power demand (kVARd), three phase total, present and peak.
 - 11. Apparent power demand (kVAd), three phase total, present and peak.
 - 12. Real energy (kWh), three phase total.
 - 13. Reactive energy (kVARh), three phase total.
 - 14. Apparent energy (kVAh) three phase total.
 - 15. Energy accumulation modes, signed, absolute, energy in, energy out.
 - 16. Total harmonic distortion (THD), voltage and current, per phase.
 - 17. Date and time stamping, peak demands, power up/restart and resets.
- A. Provide all necessary components and connections from electronic power meter to Owner's Building Management System. Coordinate requirements and installation with the Owner's control representatives.
- B. The power meter shall be accurate to 0.25% of the reading plus 0.05% of the full scale for voltage and current sensing, and 0.5% of the reading plus 0.05% of the full scale for power and energy, accurate through the 31st harmonic.
- C. Provide necessary current transformers to support current inputs to the power meter. Provide potential transformers, control power transformers, and fusing as required.

2.7 TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS) PANELS

- A. Transient voltage surge suppression (TVSS) panels shall be designed for non-linear loads incorporating transient voltage surge suppression and high-frequency electrical line noise filtering connected in parallel with the facility's wiring system. The specified unit shall be suitable for non-linear loads and shall provide effective high-energy transient voltage suppression, surge current diversion, high-frequency electrical line noise attenuation, and line control in ANSI/IEEE C62.41-1991 environments when connected downstream from the facility's main overcurrent device. Comply with all requirements of this specification for lighting and appliance and distribution panels.

- B. The manufacturer of the unit must have been engaged in the design and manufacture of such products for a minimum of five years.
- C. The specified unit shall be designed, manufactured, tested and installed in compliance with the latest edition of the following standards:
 - 1. ANSI/IEEE C62.41, C62.45
 - 2. FIPS PUB 94
 - 3. NEMA LS-1
 - 4. NFPA 70, 75 and 78
 - 5. UL 50, 67, 489, 943, 1283 and 1449.
- D. The unit shall be UL 1449, second edition listed as a transient voltage surge suppression unit.
- E. Environmental Requirements
 - 1. Operating temperature range shall be -40 degrees to +60 degrees C.
 - 2. Operation shall be reliable in an environment with 5% to 95% non-condensing relative humidity.
 - 3. The unit shall not generate audible noise greater than 35 dB at 3 feet from the unit.
 - 4. No appreciable magnetic fields shall be generated. The unit shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.
- F. Electrical Requirements
 - 1. The nominal unit operating voltage and configuration shall be as indicated on the drawings.
 - 2. The maximum continuous operating voltage of all suppression components utilized in the unit shall not be less than 115% of the facility's nominal operating voltage.
 - 3. The operating frequency range of the unit shall be 47 to 63 Hertz.
 - 4. The unit's primary mode of protection shall be line-to-neutral. The secondary modes of protection shall be line-to-ground and neutral-to-ground.
 - 5. Based on ANSI/IEEE C62.41-1991's standard 8 x 20 microsecond current waveform, the maximum repetitive surge current capacity, in amps, of the unit shall be no less than 100 KA per mode.
 - 6. The unit's published performance ratings shall be the UL 1449 Listed suppression ratings. The UL 1449 suppression rating shall be, for each mode of protection and system voltage as follows:
 - a. L-L: 700 Volts for 208Y/120 Volt, 3 phase, 4 wire systems.
 - b. L-N: 400 Volts for 208Y/120 Volt 3 phase, 4 wire systems.
 - c. L-G: 700 Volts for 208Y/120 Volt 3 phase, 4 wire systems.
 - d. N-G: 400 Volts for 208Y/120 Volt 3 phase, 4 wire systems.
- G. Documentation and Testing
 - 1. The manufacturer shall furnish an equipment manual with installation, operation and maintenance instructions for the specified unit.
 - 2. Documentation of the unit's UL 1449 suppression rating shall be included as required product data submittal information. Manufacturer shall make available upon request certified documentation of applicable Location Category Testing in full compliance with ANSI/IEEE C62.41-1991 and ANSI/IEEE C62.45-1987 guidelines.

3. A list of customer-replaceable spare parts shall be included in the unit's installation, operation and maintenance instructions. All spare parts shall be quickly and easily field-replaceable.
4. The TVSS device repetitive surge current capacity shall be tested utilizing a 1.2 x 50 microsecond waveform as defined by ANSI/IEEE 62.41-1991 and ANSI/IEEE 62.45-1992 at one minute intervals. A failure is defined as either performance degradation or more than 10% deviation of clamping voltage at the specified surge current. The device shall be capable of surviving 5000 impulses without failure or performance degradation.
5. The unit shall be factory tested and burned in at the applicable MCOV for a minimum of one hour.
6. The unit shall be provided with a five-year warranty.
7. The unit shall be thoroughly factory-tested before shipment. Testing of each unit shall include but shall not be limited to quality assurance checks, MCOV and clamping voltage verification tests.

H. Construction

1. Panel trim, box, interior, bus and circuit breakers shall be as specified for lighting and appliance panels and on the drawings. The TVSS shall be mounted integral to the panelboard equipment and shall not violate the equipment manufacturer's UL label.

I. Suppression/Filter System

1. The unit shall include an engineered solid-state high-performance suppression system, utilizing arrays of fused non-linear voltage dependent metal oxide varistors with similar operating characteristics. The suppression system's components shall optimally share surge currents in a seamless, low-stress manner assuring maximum performance and proven reliability. The suppression system shall not utilize gas tubes, spark gaps, silicon avalanche diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow to or system upset of connected loads. The suppression system shall not incorporate any other components which may degrade performance or reliability of the suppression system.
2. The fusing system shall be capable of allowing the rated maximum surge current to pass through without fuse operation. Systems utilizing a fusing system that opens below the maximum surge current level are unacceptable.
3. The unit shall include an EMI/RFI noise suppression filter capable of a minimum of -40 dB attenuation at 100 kHz.
4. Any TVSS unit mounted in a distribution panel shall have an integral disconnect or circuit breaker to be used as a means of disconnecting the suppression/filter system for maintenance and/or test purposes without interruption of power to the facility's distribution system.
5. All internal wiring associated with the suppression/filter system and subject to surge currents shall utilize low-impedance copper bus bar and/or #8 AWG copper conductor or larger. All internal connections associated with the suppression/filter system and subject to surge currents shall be made with compression solderless-type lugs and shall be bolted to the bus bars in order to reduce overall system impedance. No plug-in component modules, quick-disconnect terminals or printed circuit boards shall be used in surge current-carrying paths.
6. The unit shall include the following accessories:
 - a. The unit shall include Form C dry contacts (N.O. and N.C.) to facilitate connection to a building management system in order to monitor the on-line status of the unit. The contacts shall be normally open or normally closed and shall close or open upon failure of the suppression system and/or fuse.

- b. Operational status indicating lights.
- c. Audible alarm and alarm indicating light.
- d. Transient Voltage surge counter with battery backup.

3. EXECUTION

3.1 INSTALLATION

- A. General: Install panelboards and enclosures where indicated, in accordance with the manufacturers' written instructions, applicable requirements of the NEC and NECA's "Standard of Installation", and in compliance with recognized industry practices to ensure that products fulfill requirements.
- B. Coordinate the installation of panelboards and enclosures with cable and raceway installation work.
- C. Provide all required electrical connections within the enclosure.
- D. Fill out typewritten panelboard circuit directory cards upon completion of the installation work.

END OF SECTION 26 24 16

SECTION 26 27 26 WIRING DEVICES

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of this Section.
- B. This section is a Division 26 "Basic Materials and Methods" section, and is a part of each Division 26 section making reference to wiring devices specified herein.
 - 1. **Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
 - 2. **Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. **The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.**
 - 3. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Wiring Devices: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. The extent of wiring device work is indicated by drawings and schedules. Wiring devices are defined as single discrete units of electrical distribution systems which are intended to carry, but not utilize electrical energy.
- B. Types of electrical wiring devices in this Section include the following:
 - 1. Receptacles
 - 2. Switches
 - 3. Wall Plates
 - 4. Dimmer Controls
 - 5. Floor Outlets
 - 6. Service Pedestals

1.3 QUALITY ASSURANCE

- A. **Manufacturers:** Firms regularly engaged in manufacture of wiring devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than 3 years.
- B. **Installer:** Qualified with at least 2 years of successful installation experience on projects with electrical installation work similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with NEC as applicable to construction and installation of electrical wiring devices.
- B. UL Compliance and Labeling: Provide electrical wiring devices which have been UL listed and labeled.
- C. NEMA Compliance: Comply with NEMA standards for general and specific purpose wiring devices.
- D. NECA Compliance: Comply with NECA's "Standard of Installation."

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical wiring devices.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide products of one of the following:

- 1. Pass and Seymour Corporation
- 2. Cooper
- 3. Hubbell, Inc.
- 4. Leviton, Inc.
- 5. Crouse Hinds
- 6. Lutron
- 7. Walker Duct

2.2 WIRING DEVICES

- A. General: Where shown on the drawings, furnish and install wiring devices indicated by the appropriate symbols. Wiring devices shall be products of Pass and Seymour Corporation, or equal. Catalog numbers shown below are P & S hard use specification grade. Similar devices manufactured by Hubbell or Leviton shall be equally acceptable.

- B. Switches: Branch circuit switches shall be flush tumbler type as follows:

1. Single Pole	CSB20AC1 Series - Gray
2. Two Pole	CSB20AC2 Series - Gray
3. Three-Way	CSB20AC3 Series - Gray
4. Four-Way	CSB20AC4 Series - Gray
5. Single Pole SW With Pilot	CSB20-AC1-RPL Series

- A. Occupancy Sensors/Switches, Time Switches, Lighting Control System

- 1. Basis of design for digital lighting control system is Acuity nLight system.
- 2. Wattsopper Digital Light Management (DLM) and Hubbell NX lighting control systems are approved equivalents for the specified nLight basis of design lighting control system.
- 3. See plans for manufacturer, model number, and additional lighting control information.

2.3 RECEPTACLES

- A. All receptacles shall be side and back wired, self-grounding of the type indicated on the drawings, or as follows. Catalog numbers shown below are Pass & Seymour specification grade

unless otherwise indicated. **All project receptacles shall be tamper resistant.** Similar devices manufactured by Hubbell or Leviton shall be equally acceptable:

1.	Duplex Convenience Receptacles 20A-125V (Grounding Type)	TR63-Gray
2.	Duplex GFI Receptacle 20A-125V	2097TR Series-Gray
3.	Weatherproof Duplex GFI Receptacle 20A-125 Volt	2097TRWR-Gray with WP Wall Plate
4.	Duplex USB Receptacle	TR5362USB-Gray

2.4 PLATES

- A. Furnish and install wall plates for all wiring devices. Where switches and/or receptacles are shown adjacent to each other, provide a common cover plate for each group of devices. Oversize plates are not acceptable.
1. Plates shall be Pass and Seymour Type 302 stainless steel.
 2. Cover plates for all electrical devices shall be engraved with panel and circuit no. designation. Engraving shall be 1/8" high, block style letters, with black filler on front side of cover plates.
 3. Weatherproof switch plates shall be Crouse Hinds DS185 type.
 4. Weatherproof receptacle plates shall be "in-use" Intermatic WP5000 Series. Provide necessary number of gangs, mounting bases, inserts and gaskets. In-use covers shall be used in all wet location areas as defined by NEC 406.9(B)(1).

2.5 TWO PIECE SURFACE METAL RACEWAYS

- A. Where indicated on the drawings, provide Wiremold (or equivalent) Series ALA4800 two-piece, aluminum, surface metal raceway systems complete with all necessary electrical and telecommunications devices, bases, covers, dividers, wire clips, couples, inserts, end fittings, device mounting brackets, device covers, etc. to ensure a complete and functional installation.
- B. Cover plates for all power devices installed in two piece surface metal raceways shall be engraved with panel and circuit no. designation. Engraving shall be 1/8" high, block style letters, with black filler.

2.6 FLOOR OUTLETS

- A. Flush Mounted Floor Boxes and Floor Outlets. See plans for types. Unless noted otherwise on the plans provide one receptacle faceplate, and one blank faceplate (to support telecom devices) for each flush mounted floor convenience outlet. When carpet is indicated on the finish schedule, supply each floor box or outlet with an appropriate carpet flange.
- B. Poke-Thru Service Fittings and Service Pedestals: See plans for types. Provide all necessary faceplate types, conduit adapters for installation on counter tops and all other accessories as noted on the drawings, or as required to meet specified project needs.

2.7 Where devices are installed on exposed fittings or boxes, the plates shall be galvanized and of a type designed to fit the box. Blank covers shall be installed on all boxes without devices or fixtures, of same type as installed on devices in the room or area.

2.8 Test wiring devices to ensure electrical continuity of grounding connections and proper polarity.

3. EXECUTION

3.1 INSTALLATION

- A. Install wiring devices as indicated in compliance with manufacturer's written instructions, applicable requirements of the NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to fulfill project requirements.
- B. Coordinate with other work including painting, electrical boxes and wiring work, as necessary to interface installation of wiring devices and other work.
- C. Testing: Test wiring devices for electrical continuity of grounding connections and proper polarity. Test wiring devices to demonstrate compliance with requirements.
- D. Where devices are installed on exposed fittings or boxes, the plates shall be galvanized and of a type designed to fit the box. Blank covers shall be installed on all boxes without devices or fixtures, of same type as installed on devices in the room or area.
- E. All outlets shall be located as shown on the drawings, except that where practicable, outlets shall be located in center of panels or trim or otherwise symmetrically located to conform with existing structural layout. Outlets incorrectly installed shall be corrected. Damaged items or damaged finishes shall be repaired or replaced at no expense to the Owner.
- F. Outlets shall be set plumb or horizontal and shall extend to the finished surface of the walls, ceiling or floor, as the case may be, without projecting beyond the same.
- G. Receptacles, switches, etc., shown on wood trim, cases or other fixtures shall be installed symmetrically; and, where necessary, shall be set with the long dimensions of the plate horizontal, or ganged in tandem.
- H. Where dimmer switches are shown adjacent to standard switches, both shall be installed in separate back boxes with adequate space between so that neither cover plate requires cutting.
- I. Where devices are shown near wall openings, coordinate location if corner guards are to be installed so that cover plates do not require cutting.
- J. Where devices are shown mounted adjacent to one another on the drawings, provide multi-gang faceplates to cover all devices.

END OF SECTION 26 27 26

SECTION 26 29 13
MOTOR CONTROLLERS

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to the work of this Section.
- B. Division 26 "Basic Electrical Materials and Methods" section apply to the work specified in this Section.
- C. Control Devices: Division 23 control devices such as aquastats, electric-pneumatic and pneumatic-electric switches, thermostats, freezestats, etc. are furnished and connected by the Division 23 Contractor unless specifically noted otherwise.
- D. Motors: All motors shown on the drawings shall be furnished and set in place under the specific section in which the motor is specified.
- E. Motor starters specified in other sections of this specification such as Division 23 shall be provided with power wiring by the Division 26 Contractor.
- F. **Seismic Requirements:**
 - 1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
 - 2. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Motor Controllers: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. Extent of motor starter work is indicated by drawings and schedules.
- B. Type of motor starters specified in this Section are as follows:
 - 1. Full Voltage Non-Reversing Magnetic Starters
 - 2. Reduced Voltage Starters
 - 3. Manual Motor Starters
 - 4. Remote Controls

1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of motor starters of types, ratings and characteristics required, whose products have been in satisfactory operation in similar service for not less than five (5) years.

- B. Firm with at least three (3) years of successful installation experience on projects utilizing motor starters similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with NEC requirements as applicable to wiring methods, construction, and installation of motor starters.
- B. NFPA Compliance: Comply with applicable requirements of NFPA standard 70E "Standard for Electrical Safety Requirements for Employee Workplaces."
- C. UL Compliance: Comply with applicable requirements of UL 486A "Wire, Connectors, and Soldering Lugs for Use with Copper Connectors," and UL 508 "Electrical Industrial Control Equipment" pertaining to the installation of motor starters. Provide motor starters and components which are UL listed and labeled.
- D. IEEE Compliance: Comply with applicable requirements of IEEE Standard 241 "Recommended Practice for Electric Power Systems in Commercial Buildings" pertaining to motor starters.
- E. NEMA Compliance: Comply with applicable requirements of NEMA Standard ICS 2, "Industrial Control Devices, Controllers and Assemblies," and Pub. No. 250, "Enclosures for Electrical Equipment (1000 volts Maximum)" pertaining to motor controllers/starters and enclosures.

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's data on motor starters.
- B. Provide shop drawings of equipment being provided and control diagrams for each motor starter.

2. PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the requirements, provide motor starters of one of the following:
 - 1. Allen Bradley Co.
 - 2. General Electric Co.
 - 3. Siemens
 - 4. Square D Co.

2.2 GENERAL

- A. Except as otherwise indicated, provided motor starters and ancillary components which comply with the manufacturer's standard materials, and which are designed and constructed in accordance with published product information as required for a complete installation. Unless specifically indicated otherwise provide all power wiring, disconnects, starters, relays, hand-off-auto switches, pilot lights, motor connections, supports and all miscellaneous and necessary appurtenances required for a satisfactory and complete working system.

2.3 FULL VOLTAGE NON-REVERSING MAGNETIC STARTERS

- A. Provide magnetic starters for three phase motors. Motor starters shall be full voltage non-reversing across the line magnetic type rated in accordance with NEMA standard sizes and horsepower ratings. Magnetic starters shall not be less than NEMA size one.
 - 1. Each starter shall have a removable hinged cover capable of being padlocked. Enclosures shall be NEMA 1 general purpose type unless indicated otherwise. Provide watertight and dust tight enclosures for units installed outside, or as indicated on the drawings. Starters shall be provided with double break silver alloy contacts. All contacts shall be replaceable without removing wiring or the starter from the enclosure.
- B. Magnetic starters shall be provided with the following additional equipment:
 - 1. Overload relays shall be an integral part of the motor starter. Overload relays shall have a minimum ± 10 percent adjustment from the nominal heater rating. Heaters shall be available such that when used with the ± 10 percent adjustment, a continuous selection of motor full load currents can be obtained through the size limitations of the starter. Overload relays shall be manual reset and field convertible from manual to automatic reset. Overload relays shall be melting alloy or bimetallic type. Thermal units shall be of one piece construction and interchangeable. The starter unit shall be inoperative if the thermal unit is removed. Provide 3 overload relays, one for each phase of the three phase starter.
 - 2. Starters shall be suitable for the addition of at least three normally open and three normally closed auxiliary contacts. Provide a minimum of two normally open and two normally closed contacts unless additional contacts are scheduled on the drawings or required for proper control of the equipment.
 - 3. In each magnetic starter provide cover mounted hand-off-auto selector switch complete with a manual overload reset button and a red "On" pilot light. Provide a control transformer with a secondary voltage of 120V, complete with primary overload and short circuit protection.
 - 4. Time delay relays with time delay after energization shall be provided for starters indicated, or as required for proper control of equipment. Time delay feature shall be adjustable from 0 to 60 seconds and set as indicated on the drawings.

2.4 PART WINDING REDUCED VOLTAGE MAGNETIC STARTERS

- A. Provide Allen-Bradley Bulletin 736 part-winding starters, closed-transition, magnetic, non-reversing, reduced-inrush, two-step type. Limit line current to a maximum of 65 percent of the locked rotor current. Coordinate and verify compatibility with the motor and driven equipment. Provide starter capable of interrupting 10 times motor full load rating.
- B. Provide starters with the equipment listed in paragraph 2.3, B above.
- C. Provide additional equipment for combination starters in accordance with paragraph 2.3, B above.

2.5 WYE-DELTA REDUCED VOLTAGE MAGNETIC STARTERS

- A. Provide Allen-Bradley Bulletin 737 wye-delta starters, magnetic, non-reversing, reduced-inrush, closed-circuit transition type. Limit the inrush line current to a maximum of 35 percent of the locked rotor current. Coordinate and certify compatibility with the motor and driven equipment. Provide three thermal overload relays in series with each winding. Provide starter capable of interrupting 10 times motor full local rating.
- B. Provide starters with the equipment listed in paragraph 2.3, B above.

2.6 AUTO-TRANSFORMER REDUCED VOLTAGE MAGNETIC STARTERS

- A. Provide Allen-Bradley Bulletin 746 auto-Transformer starters, magnetic, non-reversing, reduced-inrush, closed-circuit transition type. Provide minimum tap of 65 percent for motors 30 hp or less, and 50 percent for motors in excess of 30 hp. Limit the inrush line current to a maximum of 43 percent and 25 percent respectively, of the locked rotor current. Provide thermal overload protection in each phase. Provide starter capable of interrupting 10 times motor full load rating.
- B. Provide starters with the equipment listed in paragraph 2.3, B above.

2.7 FULL VOLTAGE NON-REVERSING COMBINATION STARTERS

- A. Full voltage non-reversing combination starters shall be Square D Class 8538 (or equal) unless otherwise indicated. Provide additional equipment for combination starters in accordance with the requirements outlined in paragraph 2.3.2 above. Where combination starters are shown on the drawings, a separate starter and disconnect switch may be substituted at the Contractor's option, provided adequate space is available for the installation.
- B. Provide fused disconnect switches with Class R type fuse rejection clips. If breakers are shown, provide breakers with a minimum of 22,000 RMS symmetrical amps interrupting capacity.

2.8 MANUAL MOTOR STARTERS

- A. Thermal element type manual motor starters complete with melting alloy type thermal overload relays for single phase motors shall be Square D Class 2510. Provide overload relays sized in accordance with NEC requirements for the motor loads served.
- B. Provide flush mounted units in finished areas and surface mounted units in unfinished areas. Starter shall have NEMA I general purpose enclosure, unless otherwise indicated, and be rated for the motor horsepower required.

2.9 REMOTE CONTROLS

- A. Provide Square D standard duty oil-tight pushbuttons, pilot lights, and/or selector switches where indicated on the drawings, or wherever required for proper control of the equipment. Units shall be flush mounted in finished areas and surface mounted in unfinished areas.

3. EXECUTION

3.1 INSTALLATION

- A. Install motor starters as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices; complying with applicable requirements of the NEC, UL and NEMA Standards, to ensure that products fulfill requirements.
- B. Coordinate with other work including motor and electrical wiring/cabling work as necessary to interface installation of motor starters with other work.

- C. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Std. 486A.
- D. Install fuses in fusible disconnect switches as required.
- E. Adjusting and Cleaning: Inspect electrical starter's operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movements.
- F. Field Quality Control: Subsequent to connecting wire/cables, energize motor starter circuitry and demonstrate functioning of equipment in accordance with specified requirements. Where necessary, correct malfunctioning units and retest to demonstrate compliance. Ensure that direction of rotation of each motor fulfills requirements.

END OF SECTION 26 29 13

SECTION 26 41 00
LIGHTNING PROTECTION SYSTEM

PART 1. GENERAL

1.1 SUMMARY

- A. Provide a complete lightning protection system for the building(s) or structures shown on the contract drawings. The design of this system is to be in strict accordance with this section of the specifications and all contract drawings that apply.
- B. The lightning protection system shall be designed and installed by a firm actively engaged in the installation of Underwriters Laboratories Inc. (UL) Master Labeled Lightning Protection Systems and shall be so listed by Underwriters Laboratories Inc. The completed system shall comply with the latest editions of Underwriters Laboratories Inc. "Installation Requirements for Lightning Protection Systems, UL96A" and of the National Fire Protection Association's "NFPA® 780, Standard for the Installation of Lightning Protection Systems". The system shall be physically inspected by UL and the Master Label® Certificate of Inspection shall be provided to the building owner and made available for viewing on the UL website, <https://lps.ul.com>.
- C. The work covered under this section of the specification consists of furnishing labor, materials and services required for the completion of a functional and unobtrusive lightning protection system approved by the architect, engineer and Underwriters Laboratories Inc.
- D. System designs shall be completely integrated with the architectural design of the facility, and shall be reviewed by the Architect/Engineer prior to installation. The lightning protection system installation in shall be fully coordinated with all other trades.

1.2 STANDARDS

- A. The completed lightning protection system shall comply with the latest issue of the following standards which form a part of this specification. Where conflict occur between the two standards, the requirements of NFPA®780 shall apply.
 - 1. NFPA® 780, Standard for the Installation of Lightning Protection Systems.
 - 2. UL 96A, Installation Requirements for Lightning Protection Systems.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's descriptive and technical literature and catalog cuts.
- B. Shop Drawings: Submit installation shop drawings shall be submitted to the Architect and Engineer for coordination with other trades and approval prior to start of the installation. Shop drawings are to show the extent of the system layout designed specifically for the building(s) or structures included in the contract drawings along with installation details of the products to be used in the installation.

1.4 QUALITY ASSURANCE

- A. The installing contractor shall apply for inspection of the completed system by UL field representatives. The system is to be inspected by Underwriters Laboratories Inc, or other ANSI certified testing agency for compliance with NFPA® 780. The system shall be without deviation and the UL field representative will issue a UL Master Label® Certificate of Inspection for Lightning Protection Systems or Letter of Findings at completion of the installation, as indicated in section 3.04 below.
- B. Manufacturer: Company specializing in lightning protection equipment with a minimum of five years of documented experience.
- C. System Designer: Company specializing in the design of lightning protection systems with a minimum of five years of documented experience.
- D. Installer: Authorized installer of system manufacturer with a minimum of five years of documented experience.

PART 2. PRODUCTS

2.1 MATERIALS

- A. All materials used in the installation shall be new and shall comply in weight, size and composition as required by UL 96A and NFPA® 780 and shall be labeled or listed by Underwriters Laboratories Inc. for use in lightning protection systems. The system furnished under this specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment. The manufacturer shall be listed by UL as a manufacturer of lightning protection components.

2.2 ACCEPTABLE MANUFACTURERS

- A. Harger Lightning & Grounding.
- B. National Lightning Protection Corporation.
- C. Robbins Lightning Protection Company.
- D. Thompson Lightning Protection, Inc.
- E. Preferred Lightning Protection.

2.3 MATERIAL REQUIREMENTS

- A. Class I materials shall be used on structures or portions of structures that do not exceed 75 feet in height above grade level. Class II materials shall be used on structures that exceed 75 feet in height above grade.
- B. Copper materials shall not be mounted on aluminum, Galvalume®, galvanized steel or zinc surfaces. This includes those materials that have been painted.

- C. Aluminum materials shall not come into contact with earth or where rapid deterioration is possible. Aluminum materials shall not come into contact with copper surfaces or where exposed to runoff from copper surfaces. Aluminum materials shall not be attached to surfaces covered with alkaline-based paint, embedded in concrete or masonry, or installed in a location subject to excessive moisture.

2.4 AIR TERMINALS

- A. Air terminals shall extend a minimum of ten inches above the object or area they are to protect. Air terminals shall be located at intervals not exceeding 20'-0" along ridges of pitched roofs and along the perimeter of flat or gently sloping roofs (flat or gently sloping roofs include roofs that have a pitch less than 3:12). Flat or gently sloping roofs exceeding 50'-0" in width shall be provided with additional air terminals located at intervals not exceeding 50'. Air terminals shall be located within two feet of the ends of the ridges, roof edges and outside corners of protected areas.
- B. Air terminals shall be installed on stacks, flues, mechanical units and other objects not located within a zone of protection. Permanent metal objects on the structure having an exposed metal thickness 3/16" or greater may be substituted for air terminals and shall be connected to the lightning protection system as required by the specified standards using main size conductor and bonding plates having a minimum of 3 square inches of surface contact area.
- C. Air terminal bases shall be securely fastened to the structure in accordance with the specified standards. Fasteners may include stainless steel screws, bolts, nails, anchors or adhesive. Adhesive shall be compatible with the surface on which it is used. Any protective sheets or pads that may be required by the roofing manufacturer shall be furnished and installed by the roofing contractor.
- D. Main conductors shall be sized as Class I or Class II materials in accordance with the specified standards. Conductors shall provide a two way, horizontal or downward path from each strike or air terminal to connections to the lightning protection ground electrode system. Conductors shall be free of excessive splices and no bend of a conductor shall form an included angle of less than 90 degrees nor have a radius of bend less than 8 inches.
- E. Conductors shall be securely fastened to the structure on which they are placed at intervals not exceeding 3 feet. Fasteners shall be of the same material or of a material equally resistant to corrosion as that of the conductor. Any protective sheets or pads that may be required by the roofing manufacturer shall be furnished and installed by the roofing contractor.
- F. Connector fittings shall be listed for the purpose and of the same material as the conductor or of electrolytically compatible materials.
- G. Down conductors shall be sized as Class I or Class II materials in accordance with the specified standards. Class II conductors from a higher portion of a structure shall continue to connections to the lightning protection ground electrode system. Down conductors shall be spaced at intervals averaging not more than 100 feet around the perimeter of the structure. In no case shall a structure have fewer than two down conductors. Down conductors shall be concealed from view. All conductors shall be concealed from view at street level.
- H. In case of structural steel frame construction, down conductors may be omitted and roof conductors shall be connected to the structural steel frame at intervals not exceeding 100 feet along the perimeter of the structure.

2.5 ROOF PENETRATIONS

- A. Roof penetrations required for down conductors or for connection to structural steel framework shall be made using thru-roof assemblies with solid riser bars or conduits and appropriate roof flashing. Conductors shall not pass directly through the roof. The roofing contractor shall furnish and install the materials required to properly seal all roof penetrations of the lightning protection components and any additional roofing materials or preparations required by the roofing manufacturer for lightning conductor runs to assure compatibility with the warranty for the roof including roof pads that may be required to protect the roof under each of the lightning protection components.

2.6 GROUND ELECTRODES

- A. Each down conductor shall terminate at a ground electrode dedicated to the lightning protection system, or to a building or facility ground electrode system that consists of multiple ground electrodes that are interconnected with a ground ring conductor.
- B. Ground rod electrodes shall be copper-clad steel, a minimum 5/8" diameter and 10 feet long. The down conductor shall be connected to the ground electrode using a bronze ground rod clamp having a minimum of 1½" contact between the ground rod electrode and the conductor measured parallel to the axis of the ground rod electrode, or by an Ultraweld exothermically welded connection. Ground rod electrodes shall be located a minimum of 2 feet below grade and shall be installed below the frost line where possible (excluding shallow topsoil conditions).
- C. Where it is not possible to drive ground rod electrodes because of bedrock or shallow topsoil conditions, ground plate electrodes, radial electrodes, ground ring electrodes, concrete-encased electrodes, or combinations of these may be used in accordance with NFPA® 780.
- D. Where the structural steel framework is utilized as down conductors for the system, ground electrodes shall be connected to columns around the perimeter of the structure at intervals averaging not more than 60 feet apart. Columns shall be grounded using either bonding plates having 8 square inches of surface contact area or by Ultraweld® exothermically welded connections.

2.7 COMMON BONDING OF GROUNDED SYSTEMS

- A. Common bonding of all grounded systems within the building shall be ensured by interconnecting them to the lightning protection system using main size conductor and fittings.
- B. For structures exceeding 60 feet in height, the interconnection of the lightning protection system ground electrodes and other grounded systems shall be in the form of a ground loop conductor.
- C. These grounded systems shall include but are not limited to the electrical service, communication, and antenna system grounds as well as all underground metallic piping systems including water, gas, sewer, underground metallic conduits, etc. Interconnection to a gas line shall be made on the customer's side of the meter.

2.8 POTENTIAL EQUALIZATION

- A. Grounded metal bodies located within the required bonding distance as determined by the bonding distance formula in NFPA® 780 shall be bonded to the lightning protection system using the required bonding conductors and connections.

PART 3. EXECUTION

3.1 INSTALLATION

- A. The installation of the lightning protection system shall be done in a neat and workmanlike manner.
- B. The lightning protection system shall be installed by or under the supervision of a UL listed lightning protection installer.
- C. The installers shall have completed factory training and be so certified by the manufacturer.
- D. Install the lightning protection system in accordance with the approved coordinated shop drawing and the referenced lightning protection system installation standards. Any deviations shall be brought to the immediate attention of the manufacturer so as not to delay certification.
- E. Splices and clamps: Install cable with as few joints as possible. Use approved exothermic welded connections for all above grade connections, ungrounded conductor splices and all underground connections between conductors and ground rods. Use approved mechanical compression connections for above grade connections with specific Owner approval only.
- F. Systems shall be semi-concealed, with all down-lead conductors and groundings concealed within the building, but with roof conductors and air terminals exposed on roof. Where possible, roof conductors and air terminals shall be installed on inside faces of parapets so that they are not visible from below.
- G. Copper downlead conductors shall be used even when aluminum is required on the roof. Downlead cables in conduit shall not be brought directly through the roof. Thru roof assemblies with solid brass or stainless steel rods shall be utilized for this purpose.
- H. Ground Rods:
 - 1. Install rods by driving and not by drilling or jetting.
 - 2. Drive rods into unexcavated portions of the earth where possible.
 - 3. Where rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
 - 4. Drive to a depth such that the top of the rod will be approximately 18" below final grade or sub-grade.
 - 5. Bond exterior metal bodies on building to the lightning protection system.
- I. Corrosion Protection:
 - 1. Use no combination of materials that may form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture unless moisture is permanently excluded from the junction of such metals. Where unusual conditions exist that would cause deterioration or corrosion of conductors, use conductors with suitable protective coatings. Protect cable at all points where cable leaves concrete by wrapping rubber tape 2" on either side of the plane formed by the finished concrete surface.

3.2 COORDINATION

- A. Coordinate the installation of the lightning protection system with other trades.

- B. Coordinate all roof penetrations, fasteners and adhesive with the roofing contractor prior to installing any materials on the roof.

3.3 PROJECT DOCUMENTATION

- A. Photo document all concealed portions of the lightning protection system as they are being installed. This includes lightning protection system grounding electrodes, connections to structural metal, connections to underground metal piping entering the structure, connections to electrical and electronic service grounds, ground rings, etc. This documentation should be authenticated by the Owner or his representative.
- B. Maintain accurate "as-built" drawings throughout the entire installation of the lightning protection system.

3.4 INSPECTION, CERTIFICATION AND MAINTENANCE

- A. At completion of the installation of the lightning protection system, the contractor shall apply for inspection of the system by UL field representatives. The system is to be inspected for compliance with NFPA® 780.
- B. If the lightning protection system covers an entire independent structure and the system passes inspection, UL will issue a Master Label® Certificate of Inspection for Lightning Protection System. The contractor will submit the certificate for distribution to the premises' Owner. For the certificate to be valid, the contractor must publish the certificate to the UL website, <https://lps.ul.com> where it may be viewed by consumers, building owners, insurance agencies and other interested parties. The Master Label® Certificate of Inspection is valid for a period of five years. If the building changes structurally or if modifications are made to the system during that period, the certificate is no longer valid.
- C. At project closeout, the contractor shall provide the Owner with accurate as-built drawings as well as recommended guidelines for maintenance of the system.

END OF SECTION 26 41 00

**SECTION 26 51 00
LIGHTING**

1. GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 specification sections apply to the work of this Section.
- B. Division 26 "Basic Materials and Methods" sections apply to the work in this Section.
- C. **Seismic Requirements:**
 - 1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
 - 2. **Seismic Performance: As required, electrical system components are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. **The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.**
 - 3. **"Component Importance Factor", I_p , (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Egress Lighting: $I_p = 1.5$**
 - b. **Egress lighting Inverter and circuitry to associated lights: $I_p = 1.5$**
 - c. **Exit signs: $I_p = 1.5$**
 - d. **All other components: $I_p = 1.0$**

1.2 DESCRIPTION OF WORK

- A. Types of interior and exterior lighting fixtures in this Section include the following:

- 1. LED

1.3 QUALITY ASSURANCE

- A. **Manufacturers:** Firms regularly engaged in the manufacture of interior and exterior light fixtures of types and ratings required, whose products have been in satisfactory use in similar service for not less than three years.
- B. **Installer:** Qualified with at least three years of successful installation experience on projects with interior and exterior lighting fixture work similar to that required for this project.

1.4 REFERENCES

- A. NEC Compliance: Comply with the NEC as applicable to the installation and construction of lighting fixtures.
- B. NEMA Compliance: Comply with applicable requirements of NEMA Standard Pub. Nos. LE-1 and LE-2 pertaining to lighting equipment.
- C. ANSI/UL Compliance: Comply with ANSI/UL Standards pertaining to interior and exterior lighting fixtures for hazardous locations.
- D. UL Compliance: Provide light fixtures that have been UL listed and labeled.
- E. NECA Compliance: Comply with NECA's "Standard of Installation".

1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product data on lighting fixtures.

B. SHOP DRAWINGS

1. Furnish shop drawing portfolios (collated bound sets) containing the following information:
 - a. Name of manufacturer
 - b. Descriptive cut sheets
 - c. Complete photometric information
 - d. Coefficient of utilization tables
 - e. Fixture voltage
 - f. The number, type and wattage of the fixture lamps
 - g. Lens types
 - h. Fixture options
 - i. Fixture mounting details
 - j. Fixture door types
 - k. Construction of fixture housing and/or door
 - l. Fixture ballast manufacturer and type
2. All lighting fixtures required to be used on this project shall be submitted in one single submittal so that all fixtures can be reviewed at one time. Those fixtures not receiving a shop drawing action of "Reviewed" or "Reviewed and Noted" on the first submittal shall be resubmitted for review. A light fixture receiving a shop drawing action of "Resubmit" or "Rejected" after the third review for any reason, shall be furnished as originally specified.
3. The portfolios shall be made from standard manufacturer's specification sheets. Each fixture shall be identified by the letter or number indicated on the fixture schedule. The combining of more than one fixture type of fixture on a single sheet shall not be acceptable.

2. PRODUCTS

- 2.1 Manufacturer: Manufacturers of lighting fixtures are noted on the drawings by notes and/or by the light fixture schedule.

2.2 Substitutions: If the Contractor proposes to substitute lighting fixtures for those shown on the drawings or specified herein, he shall submit a list of proposed fixtures together with technical data to substantiate that the substitute fixtures are equivalent in all respects to the specified equipment. Proposed substitute fixtures must be submitted to the architect/engineer for review a minimum of ten (10) days prior to the project bid date. Only original documentation will be accepted for review. After review of the proposed substitute fixtures, an addendum or bid bulletin will be issued to include acceptable equipment. The review of substitute equipment in no way relieves the contractor of the responsibility to provide equipment that is equivalent in all respects to specified fixtures. Lighting fixtures as shown on the drawings or specified herein shall be used as a basis and standard of comparison in the review and consideration of fixtures of other manufacturers. The Architect/Engineer shall have the final authority as to whether the fixture is equivalent to the specified item. The proposed substitution may be rejected for the aesthetic value if felt necessary or desirable. In the event the proposed substitutions are rejected, the Contractor shall furnish the specified item.

2.3 LED Drivers

- A. Driver shall operate from 60 Hz input source of 120V through 277V with sustained variations of +/- 10 percent (voltage and frequency).
- B. Driver input current shall have Total Harmonic Distortion (THD) of less than 20 percent when operated at nominal line voltage.
- C. Driver shall have a Power Factor greater than 0.90.
- D. Driver shall avoid interference with infrared devices and eliminate visible flicker.
- E. Driver shall comply with ANSI C62.41 Category A for Transient protection.
- F. Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
- G. The luminaire shall be capable of continuous dimming over a range of 100% to 5% of rated lumen output. Dimming shall be controlled by a 0-10VDC signal.
- H. Control device must be compatible with type of driver, and coordinated prior to submission of shop drawings.
- I. If driver is remote-mounted, provide maximum allowable distances for secondary wire runs to luminaires.
- J. Provide with mounting hardware as required.

2.4 LED's

- A. Color temperature specified shall be uniform for all LED modules within like luminaire types. Color temperature measurement shall have a maximum 2 SDCM on the MacAdam Ellipse.
- B. Correlated color temperature as shown on plans. Minimum color rendering index (CRI) of 80.

- C. LED light output and efficacy shall be measured in accordance with IES LM-79 standards.
- D. LED life and lumen maintenance shall be measured in accordance with IES LM-80 standards.
- E. Rated minimum life of 50,000 hours.
- F. The individual LED's shall be connected such that a catastrophic loss or the failure of one LED will not result in a light output loss of the entire luminaire.

2.5 PLASTER FRAMES

- A. Standard plaster frames shall be provided for all recessed lighting fixtures installed in plaster or drywall finished walls or ceilings. Coordinate with architectural drawings.

3. EXECUTION

3.1 INSTALLATION

- A. Install lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of the NEC, NECA's "Standard of Installation", NEMA standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.
- B. Coordinate with other electrical work as appropriate to properly interface installation of lighting fixtures with other work.
- C. Adjust and Clean: Clean lighting fixtures of dirt and debris upon completion of the installation. Protect installed fixtures from damage during the remainder of the construction period.
- D. Field Quality Control: Upon completion of the installation of lighting fixtures, and after building circuits have been energized, apply electrical energy to demonstrate capability and compliance with the requirements. Where possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.
- E. Undercabinet and undercounter light fixtures shall be installed with 3/8" deep x 2" x 4" wood spacers painted black to provide an air space between the fixture and the top of the millwork.
- F. Lighting fixture supports: Properly support and install fixtures in strict accordance with all applicable building codes and standards. Fully and completely coordinate the installation of fixtures with actual ceiling systems, and with all building trades. In general, provide fixture supports according to the following (unless applicable codes require more restrictive support details):

1. All lighting fixtures installed in grid type suspended ceiling systems, shall be positively attached to the ceiling system with clips that are UL listed for the application. In addition, a minimum of four (4) ceiling support system rods or wires shall be provided for each light fixture and shall be installed not more than six (6) inches from fixture corners. Provide two (2) No. 12 gage hangers from each fixture housing to the building structure above (wires may be installed slack). Light fixtures that weigh more than 56 pounds shall be supported directly from the structure above by UL listed and approved hangers. Light fixtures that are smaller than the ceiling grid shall be installed at locations indicated on the reflected ceiling plans, or shall be installed in the center of the ceiling panel and shall be supported independently by at least two metal channels that span and are secured to the ceiling system.
 2. Suspended lighting fixtures shall be supported directly from the building structure without using suspended ceilings as support systems. Support systems shall be UL listed and approved for the specific installation. Where pendants or rods exceed 48 inches in length, brace support systems to limit swinging.
- G. Adjust all fixtures and aim all adjustable fixtures as directed by the Architect/Engineer.
- H. Square and rectangular fixtures shall be mounted with sides parallel to building and ceiling lines, unless otherwise noted.
- I. Where special fixtures to be used in special ceilings are scheduled, verify all ceiling system details and coordinate fixture type and accessories prior to ordering fixtures. Coordinate and cooperate with ceiling system supplier in the preparation of ceiling system shop drawings.
- J. Install fixtures as recommended by the manufacturer, or as necessary to provide exact horizontal alignment, preventing horizontal or vertical deflection, or angular jointing of fixtures suspended in continuous rows.
- K. Provide concrete bases for pole mounted fixtures as detailed on the drawings and as specified herein.
1. Concrete shall be 3000 psi, minimum.
 2. Provide anchor bolts of the size and orientation recommended by the manufacturer. The recommendations of the manufacturer shall govern the installation of all anchor bolts irrespective of any conflicting information.
- L. Where conductors are strung within poles, take all steps necessary to insure that the conductor insulation will not wear by virtue of pole movement caused by wind or similar action. Consult the pole manufacturer for recommendations.
- M. Grounding of Pole Mounted Fixtures: Connect the green ground wire specified in Section 26 05 26, "Grounding System", to the pole ground and luminaire ground.

END OF SECTION 26 51 00

SECTION 27 00 00
COMMUNICATIONS GENERAL

PART 1 – GENERAL

1.1 PURPOSE

- A. Division 27 Specifications define the standards, criteria, and assumptions for bidding, planning, furnishing, installing, testing, and documenting information transport pathways and systems. These Specifications shall form the basis for implementing the design, installation, inspection, and close-out process.
- B. Division 27 is based on NFPA 70 (NEC), National Electrical Safety Code (NESC), Institute of Electronic and Electrical Engineers IEEE, ANSI/TIA/EIA Telecommunication Standards, and BICSI methodologies. The requirements within those documents are not superseded herein unless expressly stated. As required, NEC and NESC code requirements cannot be superseded by this document at any time. ANSI/TIA/EIA standards and BICSI methodologies may be superseded, as specified, or may be made stricter by this document. The absence of a specific reference to an element of these codes, standards, and methodologies does not relieve all parties of compliance.
- C. Within this document, the word “shall” marks mandatory requirements. The word “may” or “should” suggests optional elements. The Owner shall resolve all conflicts within this document before the Contractor applies the specification.
- D. The Owner must approve any deviation from the specifications and guidelines in this document. All communications, correspondence, and approvals must be conveyed through the official project contacts of record, such as the Architect and Construction Manager.
- E. Unauthorized deviations from these Specifications may result in re-design, reconstruction, or re-installation of physical communications elements at the Contractor’s expense. Contractors shall obtain formal written approval before bidding and installation to deviate from these Specifications or ANSI/TIA/EIA standards and BICSI methodologies. Contractors shall not deviate from NEC and NESC requirements.

1.2 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. Section 27 05 00 – Common Work Results Communications
- C. Section 27 05 26 – Grounding and Bonding for Communications
- D. Section 27 05 28 – Pathways for Communications
- E. Section 27 05 53 – Identification for Communications Systems
- F. Section 27 11 16 – Communications Cabinets, Racks, Frames, and Enclosures
- G. Section 27 11 19 – Communications Termination Blocks and Patch Panels
- H. Section 27 11 23 – Communications Cable Management and Cable Runway
- I. Section 27 13 13 – Communications Copper Backbone Cabling

- J. Section 27 13 23 – Communications Optical Fiber Backbone Cabling
- K. Section 27 15 13 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 15 43 – Communications Faceplates and Connectors
- M. Section 27 16 19 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 32 23 – Voice Communications Elevator Telephones

1.3 GENERAL SCOPE OF WORK

- A. Division 27 Specifications address information transport pathways, systems, spaces, media, grounding, identification, testing, and documentation requirements supporting multiple information transport infrastructures.
- B. The project Drawings and Specifications are intended to provide complete and workable Division 27 communication systems ready for operation and use by the Owner. Any item not specifically shown in the Project Drawings or called for in the project Specifications but normally required for a fully functional system is considered a part of this contract.
- C. Specific responsibilities of Division 27 Contractor include, but are not limited to:
 - 1. Verification of all dimensions at the site and be responsible for their accuracy.
 - 2. Identify the interbuilding pathways, cabling, and space requirements to connect the subject building(s) to the campus service facilities.
 - 3. Identify the intrabuilding pathways, cabling, and space requirements to house the data/voice/video cabling systems and associated electronic information transport equipment. Pathways and spaces shall be designed and installed to support the known systems and cabling requirements and best-effort provisions for those that may be required in the future.
 - 4. Installation of new horizontal station cable, jacks, face plates, optical fiber riser cable, copper riser, distribution frame hardware, cable terminations and splicing, labeling, grounding and bonding, fire-stopping, and conformance testing of the installation.
 - 5. Additions to and connection of the communications grounding backbone furnished and installed by Division 26.
 - 6. Understanding the definition of establishing administration and labeling schemes, conforming to the Owner's requirements.
 - 7. Securing all necessary permits and licenses, paying all fees, and providing all construction work notifications.
 - 8. Compliance with all applicable laws, ordinances, and regulations.
 - 9. Mandatory Project Manager attendance at a weekly project status meeting with the General Contractor or Construction Manager
- D. Contractor shall provide cable support hardware above suspended ceilings from the sleeve through the corridor wall to the vertical secondary pathway at the outlet location.
 - 1. Staples may NEVER support, attach, or hold telecommunications or other low-voltage cables.
- E. The Contractor shall coordinate with the Owner to install cables and outlets for modular furniture panels.
- F. The Contractor shall coordinate with the Owner for through-floor and wall installations that require new penetrations.
- G. The Contractor shall coordinate the installation of the surface raceway and cables before installing the cover panels.

- H. The Contractor shall provide fire-stopping for conduits installed for telecommunications wiring.
- I. The Contractor shall provide secondary pathways as indicated on Project Drawings or as needed to support and protect cables installed under this contract.
- J. The Contractor shall disconnect and remove all existing cable and termination hardware left unused during the work under this contract.
- K. Contractor shall coordinate removals with the Owner.
- L. Unless otherwise indicated, the Owner shall provide all cutover for activation voice, data, and video services. No work to provide cutover is required.

1.4 QUALITY ASSURANCE

- A. All Division 27 design services shall be directly performed by a BICSI (Building Industry Consulting Service) RCDD (Registered Communications Distribution Designer) having a minimum of five (5) years of active design experience under this credential. Specific duties assigned to the RCDD shall include, but are not limited to, the following: all aspects of structured cabling, rack elevations, pathways, entrances, grounding, bonding, etc. The Architect shall ensure that other MEP functions do not interfere with, or otherwise infringe upon, critical elements of the design.
- B. The Contractor shall be a Belden Partner Alliance-certified company. The Telecommunication Technicians shall be Belden-certified, fully trained, and qualified to install and test the equipment. Evidence that the Contractor is qualified to install this equipment shall be included with shop drawing submittals. The Contractor shall have as an employee at least one BICSI RCDD on staff.
- C. The Contractor shall accept complete responsibility for installing, certifying, and supporting the cabling system. The Contractor must show proof that the vendor has the certifying manufacturer's support on all of these issues with shop drawing submittals
- D. Cabling Contractor shall provide with bid an RCDD and Installer-level BICSI Certification. A minimum of one (1) permanent crew member shall be BICSI Installer Level II and manufacturer-certified. Twenty-five percent (25%) of the installation force shall be BICSI Installer or manufacturer-certified. Work crew not involved in installing cable elements (e.g., laborers delivering/moving materials, installing grounding by an electrician, or installing pathway elements) do not require BICSI or manufacturer certification.
- E. Contractor shall provide with the bid a Manufacturer Certification for the system solution bid, issued directly in the bidder's company name, valid for the time frame in which the installation will be completed.
- F. The Contractor shall provide a bid of a minimum of five (5) reference accounts at which similar work, both in scope and design, has been completed by this Contractor within the last three (3) years. Three (3) of the provided references shall relate directly to the higher educational environment.
- G. The Contractor shall provide with the bid the experience profile of the RCDD responsible for managing the contract. Should the RCDD assigned to this project change during the installation, the replacement RCDD profile shall be re-submitted to the Architect, General Contractor, Construction Manager, and Owner for review and approval.
- H. Upon request, the Contractor shall arrange a visit and consultation to the referenced installations. No Contractor personnel shall be present during discussions with references.

- I. The Contractor shall know local, state, regional, and national codes and regulations. All work shall comply with the latest revision of codes or regulations. The most stringent ones shall apply when a conflict exists between local or national codes or regulations.
 - J. Only installers trained and certified by the proposed manufacturer shall be allowed to install products. Installers must possess the highest level of certification available by the manufacturer for the specific copper cabling solution being installed.
 - K. Only installers trained and certified by the proposed manufacturer shall be allowed to install firestop products.
 - L. Only installers trained and certified by the proposed manufacturer shall be allowed to terminate and test optical fiber. Others specified above may pull/place optical fiber cable under the supervision of an installer trained and certified by the manufacturer.
 - M. The Contractor may provide proof of registration/certification of planned installers in bid documents. If not included in the bid documents, the Contractor shall provide a narrative on the levels of registration/certification of their installers within the bid documents. The Contractor shall provide proof of registration/certification for the final list of installers before the start of work.
 - N. The Owner reserves the right to reject unregistered or uncertified installers performing work for which they are not registered/certified. The Contractor shall be responsible for any loss of work, schedule delays, or extra cost due to using unregistered/uncertified workers. Any additional effort on the Contractor's part to maintain the installation schedule due to the abovementioned loss time shall be the Contractor's responsibility and at the Contractor's additional expense.
 - O. The Contractor shall provide the Owner with the above-required documentation for any worker on this project brought in after the initial documentation on the installer's submittal. The Owner may periodically check installer identification and registrations/certifications during the installation.
- 1.5 DESCRIPTION OF REQUIRED SPACES AND COMMUNICATIONS CABLING ELEMENTS
- A. Entrance Facility (EF)
 - 1. The entrance facility of each building is the location where campus cables (inter-building) and intra-building services interconnect. The space shall be identified on the Project Drawings.
 - 2. The entrance facility shall house the new copper building feeder cable protection hardware. However, it does not permanently house the main cross-connect frame (MC).
 - 3. The entrance facility may house communications electronics, which the Owner shall install and activate.
 - 4. The EF shall be equipped with electrical power 110 VAC and 208 VAC L6 30 R, plywood backboard, lighting, floor covering, paint, and HVAC
 - 5. If units are stacked, the EF shall be connected to all MCs, TRs, and ERs via the appropriate trade-size conduit or sleeve system, maintaining proper fill capacity.
 - 6. The EF shall have a minimum of 2-4" conduits to the property line or OSP feed location on new construction. (See Owner Standards for details)
 - 7. All conduits installed inside and outside the building shall include pull strings or mule tape.
 - B. Main Cross-connect (MC)
 - 1. Copper and fiber backbone cables extend from the MC to telecommunication closets, as shown on the Project Drawings. The MC also serves as a Telecommunications Room for services to the work areas.
 - 2. The MC includes termination hardware, equipment racks, patch panels, cable management hardware, and network electronics.
 - 3. The MC shall house the telecommunications main grounding busbar (TMGB). The bonding backbone cables shall extend from the TMGB to each of the Telecommunications Rooms as

- shown on the Project Drawings
4. If units are stacked, the MC shall be connected to the EF, TR, and ER via the appropriate trade-size conduit or sleeve system, maintaining proper fill capacity.
- C. Telecommunication Room (TR)
1. The TR is the location for cross-connecting the backbone and horizontal station cables.
 2. The space houses the new horizontal cross-connect (HC) distribution frames. Horizontal station cables are home-run from the work area to the distribution frame. TR locations and serving boundaries are shown on the Project Drawings.
 3. The TR shall have electrical power 110 VAC and 208 VAC L6-30 R, plywood backboard, lighting, floor covering, paint, and HVAC.
 4. The TR will house communications electronics, which the Owner shall install and activate.
 5. The TR shall house a telecommunications grounding busbar (TGB).
 6. The TR includes equipment racks, cable management hardware, termination hardware and labeling.
 7. If units are stacked, the TR shall be connected to the EF, MC, TRs, and ERs via the appropriate trade size conduit or sleeve system, maintaining proper fill capacity.
 - a. All conduits must include pull strings or mule tape.
- D. Intermediate Cross Connect (ICC)
1. The ICC is a remote distribution frame dedicated to a specific area within a building.
 2. Communications outlets in the defined area shall be cabled back to the ICC rather than the local TR (Telecommunications Room).
 3. Verify with the Owner those outlets cabled from an ICC.
 4. Refer to Project Drawings for constructing ICC and the service areas.
- E. Backbone Riser Cable
1. Hybrid and composite cables shall not be installed under this contract.
- F. Copper Entrance Cable
1. Install all the copper entrance cables, termination hardware, protection hardware, labeling, providing splice cases, and testing for the building as shown on Project Drawings.
- G. Copper Riser Cable
1. New copper riser cables are home-run from the MC to each TR in a star topology.
 2. Copper riser cables shall be a minimum of 25 pairs.
 3. Install copper riser cable, termination hardware, labeling, and provide testing for the copper riser system as shown on the Project Drawings.
- H. Optical Fiber Riser Cable
1. The optical fiber riser cables shall extend from the MC to the TR in a ring and a star topology.
 2. Install optical fiber riser cables from the MC to each TR. Refer to the Project Drawings.
 3. Optical fiber riser cables shall be a minimum of 12 strands.
 4. Install termination hardware, enclosures, labeling, and testing for the optical fiber riser system as shown on the Project Drawings.
 5. Hybrid and single mode /multimode optical fiber cables are only used if specified.
- I. Coaxial Riser Cable
1. The video riser cables shall extend from the MC to the TRs in a trunk and tap topology.
 2. Provide coaxial riser cable from the MC to each TR. Refer to the Project Drawings.
- J. Horizontal Station Cable and Work Area Outlets
1. Horizontal station cable distribution follows a star topology. Each station cable is home-run from the outlet location in the work area to the distribution frame serving that area. Serving area boundaries are shown on the Project Drawings.
 2. The cable type provided to each outlet varies and is indicated on the Project Drawings.

3. Install horizontal station cables, termination hardware, and labeling and provide testing and documentation.
4. Horizontal station cable installations shall be tested. Refer to Section 17961.
5. The location of outlets shall not be changed in the field without the Owner's approval.
6. The quantity of cables to each outlet and the work at each location is keyed to the outlet symbol. Unless otherwise noted, each outlet location shown on the Project Drawings will receive a new cable. The following description of work applies unless otherwise noted.
 - a. For each new communications outlet, install new cables, jacks, faceplates, icons, blank inserts, and termination hardware at both cable ends. Label both cable ends and test the installation. In the TR, terminate cables on the appropriate frame for voice, data, or video services. Refer to Project Drawings.
 - b. Install a specified wall-phone mounting plate with telephone mounting lugs and a jack at each wall-mount communications outlet. Terminate the first 4-pair group on the wall plate jack. Coil the unused 4-pair cable in the outlet box. Label and test the installation. In the TR, terminate the UTP cable on the voice frame. Refer to the Project Drawings. Terminate cable pairs to provide appropriate pair-pin assignments.
7. The Contractor shall route cables through a built-in raceway system in modular furniture when available.
8. The Contractor shall route cables through cable management per the manufacturer's instructions.
9. The Contractor shall coordinate with the Owner and others to install cables to connect specific systems, such as elevator phones, HVAC controllers, security alarms, and door lock controllers.
10. A standard Work Area Outlet comprises 2-CAT 6A Jacks (duplex) in a single faceplate.
11. Office spaces should include 2 standard Work Area Outlets on opposing walls within 3 feet of an electrical outlet.

K. Primary Pathways

1. Primary pathways are major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas, which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.
2. The Contractor shall provide fire stopping for conduits and sleeves installed for the use of telecommunications wiring.
3. The Contractor shall provide primary pathways as indicated on the Project Drawings.

L. Secondary Pathways

1. Secondary pathways extend from the primary path to the communication outlet box and carry cable from the primary path to the outlet box.
2. The Contractor shall provide fire stopping of conduits installed for telecommunications wiring.
3. The Contractor shall provide secondary pathways as indicated on the Project Drawings or as needed to support and protect cables installed under this contract.

1.6 COORDINATION

- A. The buildings on the Owner's campus house ongoing activities and active network connections, which shall not be interrupted without strict coordination with the Owner and occupant. Before beginning work, coordinate and schedule all construction work with the Owner and occupant.
- B. Coordinate with the Owner to identify where existing facilities can be accessed to provide interconnection between new and existing cables. These spaces shall be identified on the Project Drawings.
- C. All Division 27 Contractor Project Managers shall schedule and conduct a coordination meeting with the Owner to confirm and coordinate the scope of work requirements before the commencement of work, whether the project is new construction, renovation, or retrofit. Project

meetings shall be scheduled through the General Contractor, Construction Manager, or Owner, depending upon how the project management process is structured in each instance.

- D. The Contractor shall submit a work schedule before any work begins. This schedule shall identify the major phases of the installation. The Architect or Construction Manager shall review the schedule with the Owner's representatives, identify inspection requirements based on phasing, and request any required modifications to the installation schedule. When the installation plan is finalized and approved, work may begin.

1.7 CUTOVER

- A. Unless otherwise indicated, the Owner shall provide all cutover for activation voice, data, and video services. No work to provide cutover is required.
- B. The Contractor shall provide all documentation, test results, label schedules, and as-built information no less than 14 days before the scheduled cutover date.
- C. The following are required for cutover to commence:
- D. Two weeks (14 days) before the scheduled cutover date, the following work shall be 100% complete:
 - 1. All work in the entrance facility and Telecommunications Rooms, including punch list items. During this period, the Owner will install equipment.
 - 2. Installation, termination, labeling, and testing of optical fiber cables.
- E. Two weeks (14 days) before the scheduled cutover date, the Owner shall receive from the Contractor the following:
 - 1. Printed copper station cable performance test results.
 - 2. Printed optical fiber test results.
 - 3. Completed Copper Station Cable Recording Documents
 - 4. Completed Fiber Label Recording Documents (refer to Section 171110).
 - 5. Marked-up set of drawings showing field changes.
- F. Cutover date shall start with the Owner's technicians testing jacks, cables, fibers, and riser cables. The Owner's technicians will repair the defects found at \$75.00 per hour. Total cost of repair to be charged to General Contractor

1.8 SUBMITTALS

- A. Refer to Division 1 and the General Provisions of the Contract for exact submittal procedures.
- B. Work shall not proceed without the Owner and Architect's approval of all submitted items.
- C. Shop drawings shall be submitted before construction to prevent any delay in other Contractors' work and allow the Architect reasonable time to review them and make necessary corrections.
- D. It will be assumed that the Contractor has examined the shop drawings and equipment brochures before submission and that the materials and equipment depicted will readily fit into the construction. The Contractor shall also review all completed work related to materials or equipment depicted to ensure that it has been properly installed.
- E. No materials or equipment subject to prior review by the Architect shall be fabricated or installed by the Contractor without such review and approval. The Architect's review of such drawings and brochures shall not relieve the Contractor of responsibility for deviations from the requirements of the drawings and specifications unless he has notified the Architect in writing

- F. The Division 27 Contractor shall provide multiple copies of the following items for review, without exception, before material acquisition and installation, as required by the General Contractor or Construction Manager, as applicable. Specific requirements shall be listed and described within each Division 27 section. Failure to submit the required items shall disqualify the bidder.
1. Product Data Sheets (Catalog Cuts)
 2. Backbone/Riser/Cabling Diagrams
 3. System Schematics
 4. Specification Sheets for Test Equipment
 5. Bill of Materials
 6. Contracting Firm Qualifications and Certifications
 7. Installation Team Qualifications by Individual
 8. Current Manufacturer Certifications
- G. The Contractor shall provide Coordination Drawings for review, without exception, before material acquisition and installation for approval to proceed. Coordination Drawings shall consist of floor plans and building sections drawn to scale. Include scaled Cable Tray/Runway layout and relationships between components and adjacent structural and mechanical elements. Show the following:
1. Vertical and horizontal offsets and transitions.
 2. Clearances for access above and to the side of Cable Tray/Runways.
 3. Vertical elevation of Cable Tray/Runways above the floor or bottom of the ceiling structure.
- H. Provide throughout installation:
1. Material samples, if requested by the Architect, General Contractor, or Construction Manager.
 2. Periodic field quality control reports.
 3. Periodic cable test reports.
- I. Provide before completion:
1. The Architect, General Contractor, or Construction Manager must approve actual samples of the component labeling scheme to be applied to cabling components.
 2. Draft cable administration drawings, as requested, to assist the Owner in the planning process. Drawings will be requested before final documentation and reproductions of handwritten field copies.
- J. Provide after each construction/testing phase or area, as defined by the General Contractor or Construction Manager:
1. Cable test and certification reports; summary hard copy or full test results on compact disc when requested by the General Contractor, Construction Manager, Owner, or Architect. Reports shall be submitted to the requesting party within thirty (30) working days of completion for each phase.
 2. One (1) full-size final drawing of the installation for the Division 27 systems. The drawings shall be given as D or E-size originals and on disc in AutoCAD format.
- K. Provide after the installation is complete
1. One (1) full-size set of record drawings for the Division 27 systems installation. The drawings shall be given as D or E-size originals and on disc in AutoCAD format.
- L. Provide, after the installation is complete and two (2) weeks before final acceptance, three (3) bound sets of O&M (Operating and Maintenance) Manuals formatted as defined by Division 1 and within Section 270000. In addition to the specific requirements contained within each Division 27 sub-section, each copy of the O&M Manual shall include, at minimum, items listed as follows:
1. One (1) copy of each approved submittal.
 2. Cable test and certification reports; summary hard copy and complete test results on disc.
 - a. All test data, including documentation of failed tests, the corrective procedures

- performed, and the re-test results, shall be documented and submitted on CD-ROM in hard copy and ASCII format.
- b. Hand-written test reports shall not be accepted.
- c. All actions required to correct failed tests shall be documented, including the cable identifier, failed tests, and actions performed to correct the problem.
- 3. Instruction manuals, including equipment and cable schedules, operating instructions, and manufacturer's instructions.
- 4. Manufacturer Warranty Certificate.
- 5. Warranty contacts, including but not limited to names and telephone numbers (office and mobile).

1.9 CODES & STANDARDS

- A. All work shall comply with the following codes and agencies. Nothing contained within these Specifications shall be misconstrued to permit work not in conformance with the most stringent of applicable codes and standards. It is assumed that bidders have access to, and specific knowledge of, the listed reference materials to ensure conformity with them.
 - 1. National Electrical Code (NEC)
 - 2. National Electrical Safety Code (NESC)
 - 3. National Fire Protection Association (NFPA)
 - 4. Federal, State, and Local Codes.
 - 5. National Electronic Manufacturer's Association (NEMA)
 - 6. Institute of Electronic and Electrical Architects (IEEE)
 - 7. American National Standards Institute/Electronic Industries Association/Telecommunication Industries Association (ANSI/EIA/TIA)
 - 8. Occupational Safety & Health Administration (OSHA)
 - 9. Federal Communications Commission (FCC)
- B. All new materials, equipment, and installation practices shall meet or exceed the requirements of the following standards unless specifically instructed otherwise by the Architect.
 - 1. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual (TDMM) 12th, or most recent, edition.
 - 2. Building Industry Consulting Service International (BICSI) Information Transport Systems Installation Manual (ITSIMM) 4th, or most recent, edition.
 - 3. Building Industry Consulting Service International (BICSI) Outside Plant Design Reference Manual (OSPDRM) 4th, or most recent, edition.
 - 4. ANSI/NECA/BICSI 607-D 2019, Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
 - 5. ANSI/NECA/BICSI-5682006 Standard for Installing Commercial Building Telecommunications Cabling
 - 6. ANSI/TIA-568.1-D-2015, Commercial Building Telecommunications Cabling Standard 2015, or the most recent edition
 - 7. ANSI/TIA-568.2-D 2018, Balanced Twisted-Pair Telecommunications Cabling and Components Standard 2018, or the most recent edition
 - 8. ANSI/TIA-568.3-D 2016, Optical Fiber Cabling Components Standard 2016, or the most recent edition
 - 9. ANSI/TIA/EIA-569-E 2019, Commercial Building Standard for Telecommunications Pathways and Spaces
 - 10. ANSI/TIA/EIA-606-C 2017, Administration Standard for Commercial Telecommunications Infrastructure
 - 11. ANSI J-STD-607-D 2019, Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 12. ANSI/TIA/EIA-758-B 2012, Customer Owned Outside Plant Telecommunications Infrastructure Standard
 - 13. TIATSB-162, Telecommunications Cabling Guidelines for Wireless Access Points
 - 14. NFPA 70-2017 National Electrical Code (NEC), or most current edition

- a. With special emphasis on Articles 770 and 800
- 15. IEEE C2-2002 National Electrical Safety Code (NESC), or most current edition
- 16. IEEE Std 1100 (IEEE Emerald Book)
- 17. IEEE Project 802, Remote Powering via MDI/RJ-45
- 18. IEEE Project 802.3af-2005/Corr1-2006, Isolation Requirements
- 19. IEEE Project 802.3an-2006, 10GBASE-T Ethernet
- 20. IEEE 81-1983 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
- 21. UL 1459 Underwriters Laboratories Standard for Safety – Telephone Equipment
- 22. UL 1863 Underwriters Laboratories Standard for Safety – Communications Circuit Accessories
- 23. UL 467-2004 Grounding and Bonding Equipment
- 24. UL 50 Electrical Cabinets and Boxes
- 25. UL 1076 Security Systems
- 26. UL 294 Access Control
- 27. NEMA 250
- 28. OSHA CFR Standards-29, Section 1910 or most current edition.
 - a. 1910.268 Telecommunications
 - b. 1910.146 Permit-Required Confined Spaces
- 29. FCC Part 68 Code of Federal Regulations, Title 47 Telecommunications
- 30. FCC 47 CFR 68
- 31. ADA Americans with Disabilities Act

1.10 DEFINITIONS

- A. Amplifier (CATV): A device that boosts the strength of a CATV signal.
- B. APC: Angle Physical Connector – An optical fiber connector that is polished at an angle of 8 to 10 degrees to reduce the back reflection of the signal.
- C. A-Side refers to backbone cabling associated with the primary backbone/riser system originating at “MC-A” (Main Cross-Connect A). The A-Side functions as a fully independent and redundant system compared to the B-Side).
- D. Attenuation: The decrease in the power of a signal, light beam, or light wave, either absolutely or as a fraction of a reference value. Attenuation is the opposite of gain and is measured in decibels (dB).
- E. Backbone System: The cabling and connecting hardware interconnects between Telecommunications Rooms, Equipment Rooms, and entrance facilities.
- F. BCT: Bonding Conductor for Telecommunications – A conductor that interconnects the building's service equipment (power ground) to the telecommunications grounding system.
- G. BET: Building Entrance Terminal - Cable termination equipment used to terminate outside plant (OSP) cables at or near the building entry point.
- H. B-Side refers to backbone cabling associated with the secondary back-bone/riser system originating at “MC-B” (Main Cross-Connect B). The B-Side functions as a fully independent and redundant system compared to the A-Side).
- I. CBN: Common Bonding Network – The principal means for effective bonding and grounding inside a telecommunications facility or data center. The CBN has a mesh topology connected to the grounding electrode system.
- J. Coaxial Cable: A cable composed of an insulated central conducting wire wrapped in another

cylindrical conducting wire and then wrapped in another insulating layer and an outer protecting layer.

- K. Conduit Chase Pipe: A short section of bushed EMT conduit with sufficient size and capacity to support horizontal cabling bundles from ceiling space through ceiling tile onto the cable runway system connecting wall to rack or cabinet.
- L. Construction Area: The areas identified on drawings, specifications, and contract documents, as well as the areas affected by the work, including all areas of the building.
- M. dBmV: (CATV) A signal measurement whereby 0 dBmV equals 1000 microvolts across 75 ohms. A recommended signal level for a TV to receive is 10 dBmV.
- N. Distribution Amplifier (CATV): A device that provides several isolated outputs from one looping or bridging input and has a sufficiently high input impedance and input-to-output isolation to prevent loading of the input source.
- O. EDA: Equipment Distribution Area - Equipment racks or cabinets occupy the data center space.
- P. Entrance Facility: Each building's entrance facility is where campus cables (inter-building) and intra-building services interconnect.
- Q. ER: Equipment Room—A centralized space designed for telecommunications equipment that serves the occupants of a building. Because of its nature or complexity, equipment in an ER is considered distinct from a TR (Telecommunications Room). It is also frequently referred to as MDF.
- R. F-Connector (CATV): The final piece of hardware on a cable designed for CATV, DBS, or other signal distribution applications. It is cylindrical with a center pin protruding out and plugs into the set-top box, cable-ready TV, satellite receiver, or VCR.
- S. Fusion Splicing: An optical fiber splicing method that consists of two clean (stripped of coating) cleaved fibers, which are then joined and fused with an electric arc.
- T. GE: Grounding Equalizer – A conductor that interconnects elements of the telecommunications grounding infrastructure (formerly Telecommunications Bonding Backbone Inter-connecting Bonding Conductor).
- U. HC: Horizontal Cross-Connect – A group of connectors, such as patch panels or punch-down blocks, that allows equipment and backbone cabling to be cross-connected with patch cords or jumpers. Floor Distributor (FD) is the international term for HC. It is also frequently called TR or IDF (legacy term).
- V. Headend (CATV): A CATV systems control center where incoming signals from satellites and other sources are fed into a distribution system. The originating point of a signal in CATV systems.
- W. Horizontal System: The cabling between, and including, the TO (Telecommunications Outlet) connector and the HC (Horizontal Cross-connect) in the Telecommunications Room.
- X. HDA: Horizontal Distribution Area – A space within the Data Center where a Horizontal Cross-Connect is located that may include LAN switches, SAN switches, and KVM switches for the end equipment located in the EDA (Equipment Distribution Area).
- Y. ICC: The ICC is a remote distribution frame dedicated to a specific area within a building.

- Z. IDF: Intermediate Distribution Frame – An enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the Backbone and Horizontal Systems. It is also frequently referred to as TR.
- AA. J-Hook: A supporting device for horizontal cables shaped like a “J”. It is attached to some building structures. Horizontal cables are laid in the opening formed by the “J” to provide support for cables.
- BB. LC: Lucent Connector—A small form factor (SFF) single-fiber optical fiber connector used to terminate both multimode and single-mode optical fiber cables. The housing mechanism of the LC connector (simplex and duplex) is a push-pull type connection.
- CC. Line Amplifier (CATV): An amplifier for audio or video signals that feeds a transmission line; also called a program amplifier.
- DD. MC: Main Cross-Connect—The Cross-Connect is generally located in the EF, MDF, or ER for the cross-connection and interconnection of entrance cables, first-level backbone cables, and equipment cables. Campus distributor is the international term for MC, also frequently referred to as MDF.
- EE. MDA: Main Distribution Area – The space in the Data Center where the Main Cross-Connect is located.
- FF. Minor Pathway Support Hardware: Anchors, support brackets, clamps, clips, cable ties, D-rings, rack screws, Velcro straps, etc., used to dress and secure cabling, conduits, and surface raceways.
- GG. Modulator (CATV): The electronic equipment required to combine video and audio signals and convert them to TV radio frequencies (RF) for distribution to other equipment (including televisions) on a CATV system.
- HH. MTP: Multi-Fiber Termination Push-On Connector – an optical fiber connector built upon the MTP ferrule with (12) fibers or (6) duplex channels.
- II. Multimode Optical Fiber: Optical fiber with a core diameter of 50 or 62.5 microns (micrometers) and a cladding diameter of 125 microns; lightwave propagation allows many modes within the multimode fiber. Also abbreviated as MM or FOMM.
- JJ. Networking & Telecommunications: The University of Missouri—Kansas City entity responsible for all information transport infrastructure defined within Division 27, also referred to as IT.
- KK. Optical Loss Test Set (OLTS): A stabilized light source and optical power meter tool that directly measures loss by computing the difference between the optical power entering a fiber element/strand and the optical power exiting it. Required functionality for Tier 1 testing.
- LL. Optical Time Domain Reflectometer (OTDR): An instrument that measures transmission characteristics by sending short light pulses down an optical fiber element/strand and providing a graphic representation of the backscattered light. Required functionality for Tier 2 testing.
- MM. Primary Pathway: Primary pathways are major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas, which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.
- NN. Primary Protector: A device that limits the voltage between telecommunications conductors and the ground (usually between 215 volt direct current [VDC] and 350 VDC). 2. A protective device

placed on telecommunications conductors per codes and standards such as NFPA 70.

- OO. Radio Frequency (RF): The area (or band) of the electromagnetic spectrum where most radio communication occurs, typically from 100 KHz to 100 GHz. A frequency at which coherent electromagnetic radiation of energy is helpful for communication. Analog electrical signals are sent on cable or over the air. Conventional (broadcast) television and radio and cable TV deliver RF signals to your television/radio.
- PP. SC: Subscriber Connector – An “full-size” optical fiber connector used to terminate multimode and single-mode optical fiber cables (simplex and duplex) with a square front profile and a push-pull latching mechanism.
- QQ. Secondary Pathway: Secondary pathways extend from the primary path to the communication outlet box. Secondary pathways carry cable from the primary pathway to the communication outlet box.
- RR. Secondary Protector: A secondary voltage protector with the indoor communications wire and cable between the primary protector and the equipment is installed in series. The secondary protector provides over-current protection that will safely fuse at currents less than the current-carrying capacity of the device intended to protect.
- SS. SE: Service Entrance—An entrance to a building for both public and private network service cables. It is a facility that provides all necessary mechanical and electrical services for the entry of telecommunications cables into a building and that complies with all relevant regulations.
- TT. Single Mode Optical Fiber: Optical fiber with a relatively small core diameter of 8–9 microns (micrometers) and a cladding diameter of 125 microns; lightwave propagation is restricted to a single path, or mode, in single-mode optical fiber. Also abbreviated as SM or FOSM.
- UU. Splice: A joining of conductors meant to be permanent. 2. A device that joins conducting or transmitting media. It is also referred to as a straight splice.
- VV. Splice Case: A metal or plastic housing with a semi-cylindrical cavity that clamps around a cable splice and provides a closure.
- WW. Splitter (CATV): A passive device splits a signal into two or more lower-level output signals.
- XX. Tap (CATV): A device used on community antenna television cables to match impedance and connect service drops.
- YY. TBB: Telecommunications Bonding Backbone - A copper conductor connects the Telecommunications Main Grounding Busbar (TMGB) to the Telecommunications Grounding Busbar (TGB).
- ZZ. TE: Telecommunications Enclosure - A case or housing for telecommunications cable terminations and cross-connect cabling.
- AAA. TGB: Telecommunications Grounding Bus Bar—This is a common point of connection for the telecommunications system and equipment bonding to the ground, and it is located in the telecommunications room or equipment room.
- BBB. TMGB: Telecommunications Main Grounding Bus Bar - A bus bar placed in a convenient and accessible location and bonded to the building service equipment (power) ground using the bonding conductor for telecommunications.

CCC. TO: Telecommunications Outlet—A device placed at the user workstation for terminating horizontal media and connecting network equipment. It is also referred to as a WAO (Work Area Outlet).

DDD. TR: Telecommunications Room – An enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the recognized cross-connect between the Backbone and Horizontal Systems. It is also frequently referred to as IDF (legacy term).

EEE. Transition Splice: A planned splice point at the building entrance used to transition from non-rated outdoor to indoor-rated cable designs.

FFF. WAO: Work Area Outlet - A device placed at the user workstation for termination of horizontal media and for connectivity of network equipment. Also referred to as TO (Tele-communications Outlet).

GGG. ZDA: Zone Distribution Area – A space in the Data Center where a zone outlet or consolidation point is located.

1.11 ACRONYMS & ABBREVIATIONS

- A. ACR: Attenuation-to-Crosstalk Ration
- B. ADA: Americans with Disabilities Act
- C. AFF: Above Finished Floor
- D. ANSI: American National Standards Institute
- E. APC: Angle Physical Connector
- F. ASTM: American Society for Testing & Materials (ASTM International)
- G. AWG: American Wire Gauge
- H. BCT: Bonding Conductor for Telecommunications
- I. BER: Building Entrance Room
- J. BET: Building Entrance Terminal
- K. BICSI: Building Industry Consulting Service International, Inc.
- L. BTU: British Thermal Unit
- M. CATV: Community Antenna Television (Cable Television)
- N. CBN: Common Bonding Network
- O. CD: Campus Distributor
- P. dB: Decibel
- Q. dBmV: Decibel MilliVolt
- R. EDA: Equipment Distribution Area

S. EF: Entrance Facility

T. EIA: Electronic Industries Association

U. ELFEXT: Equal Level Far-End Crosstalk

V. EMC: Electromagnetic Compatibility

W. EMI: Electromagnetic Interference

X. EMT: Electrical Metallic Tubing

Y. ER: Equipment Room

Z. FCC: Federal Communications Commission

AA. FD: Floor Distributor

BB. FEXT: Far-End Crosstalk

CC. FOMM: Fiber Optic Multimode

DD. FOSM: Fiber Optic Single Mode

EE. FOTP: Fiber Optic Test Procedure

FF. Freq: Frequency

GG. GE: Grounding Equalizer (replacing TBBIBC)

HH. Gnd: Ground

II. HB: Hand Box

JJ. HC: Horizontal Cross-Connect

KK. HDA: Horizontal Distribution Area

LL. HH: Hand Hole

MM. HVAC: Heating, Ventilation, and Air Conditioning

NN. Hz: Hertz

OO. ICC: Intermediate Cross-Connect

PP. IDC: Insulation Displacement Connector

QQ. IDF: Intermediate Distribution Frame

RR. IEEE: Institute of Electrical and Electronics Architects

SS. ISO: International Standards Organization

TT. ISP: Inside Cable Plant

UU. IT: Information Technology

VV. LAN: Local Area Network

WW. LC: Lucent Connector

XX. Mbps: Megabits per second

YY. MC: Main Cross-Connect

ZZ. MDA: Main Distribution Area

AAA. MDF: Main Distribution Frame

BBB. MH: Maintenance Hole

CCC. MHz: Megahertz

DDD. MM: Multimode

EEE. MTP: Multi-Fiber Termination Push-On

FFF. NEC: National Electrical Code, NFPA 70

GGG. NESC: National Electric Safety Code

HHH. NFPA: National Fire Protection Association

III. NRTL: Nationally Recognized Testing Laboratory

JJJ. OLTS: Optical Loss Test Set

KKK. OSHA: Occupational Safety and Health Administration

LLL. OSP: Outside Plant

MMM. OTDR: Optical Time Domain Reflectometer

NNN. PR: Pair

OOO. RCDD: Registered Communications Distribution Designer

PPP. RFI: Radio Frequency Interference

QQQ. RH: Relative Humidity

RRR. SC: Subscriber Connector

SSS. SE: Service Entrance

TTT. SM: Single Mode

UUU. TBB: Telecommunication Bonding Backbone

VVV. TBBIBC: Telecommunications Bonding Backbone Interconnecting Bonding Conductor

WWW. TGB: Telecommunications Grounding Bus bar

XXX. TIA: Telecommunications Industry Association

YYY. TMGB: Telecommunications Main Grounding Bus Bar

ZZZ. TO: Telecommunications Outlet

AAAA. TR: Telecommunications Room

CCCC. UL: Underwriters Laboratory

DDDD. UPS: Uninterruptible Power Supply

EEEE. UTP: Unshielded Twisted Pair

FFFF. WAO: Work Area Outlet

GGGG. WAP: Wireless Access Point

HHHH. ZDA: Zone Distribution Area

PART 2 – PRODUCTS

2.1 REFERENCE BRANDS AND PART NUMBERS – BASIS OF DESIGN

- A. Reference brands and part numbers listed within Division 27 represent the Basis-of-Design and are as required by the Owner. Alternates may be proposed but shall meet or exceed specifications for the items listed. Acceptance shall be at the sole discretion of the Owner.
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. Before submitting bids, the Contractor shall call to the attention of the Architect any materials or apparatus that the bidder believes to be inadequate and any necessary items of work omitted.
- D. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.
- E. Reference Cable Specifications

Manufacturer	Part Number	Description	Section Reference
27 05 00 – Common Work Results for Communications			
3M Fire Protection Products	CP25, CP25WB	Fire Barrier Caulking	27 05 00
Dow Corning	2000	Firestop Sealant	27 05 00
Hilti Construction Chemicals	CS240	Firestop Sealant	27 05 00
RectorSeal Corporation	950/1000	Metacaulk Intumescent Firestop Sealant	27 05 00
3M Fire Protection Products	FS-195	Fire Barrier Wrap Strip	27 05 00

Manufacturer	Part Number	Description	Section Reference
Dow Corning	2002	Firestop Intumescent Wrap Strip	27 05 00
Hilti Construction Chemicals	CS2420	Intumescent Wrap	27 05 00
3M Fire Protection Products	MPS-2 Plus	Moldable Putty Stix	27 05 00
RectorSeal Corporation	66335, 66340, 66345	Metacaulk Putty Pads and Sticks	27 05 00
Arlington	EMT400	Insulated Plastic Bushings	27 05 00
Contractor Selected		Plywood Backboards	27 05 00
Contractor Selected		Miscellaneous Hardware	27 05 00
27 05 26 – Grounding and Bonding for Communications			
Newton Instrument Company	3056	¼" x 4" x 20" Insulated Copper Ground Bar	27 05 26
Newton Instrument Company	3058	¼" x 4" x 10" Insulated Copper Ground Bar	27 05 26
Newton Instrument Company	4028	¼" x 1" x 19" Insulated Copper Ground Bar	27 05 26
Newton Instrument Company	3059	¼" x 4" x 12" Insulated Copper Ground Bar	27 05 26
Contractor Selected		No. 3/0 AWG Insulated Copper IC (Interconnecting Bonding Conductor) for Telecommunications	27 05 26
Contractor Selected		No. 3/0 AWG Insulated Copper TBB (Telecommunications Bonding Backbone)	27 05 26
Contractor Selected		No. 6 AWG Green Insulated Copper EK (Equipment Bonding Conductor)	27 05 26
Thomas and Betts	54816BE	Two Hole Compression Lug, Long Barrel, Blue	27 05 26
Thomas and Betts	54905BE	One Hole Compression Lug, Long Barrel, Blue	27 05 26
Contractor Selected		Miscellaneous Hardware	27 05 26
27 05 28 – Pathways for Communications			
Cable Management Solutions	CM301-6-X	Snake Canyon Full Width Basket Straight Section 23" wide x 6" deep x 24" long	27 05 28
Cable Management Solutions	CM301-6-TC-X	Snake Canyon Turning Component 23" wide x 6" deep x 24" long	27 05 28
Cable Management Solutions	CM301-CG	Snake Canyon Universal Crossing Grid 31" wide x 31" long	27 05 28
Cable Management Solutions	CM301-TO	Snake Canyon Cable Drop Out 22" x 7"	27 05 28
Cable Management Solutions	CM301-TRCB	Snake Canyon Pedestal Mount Bridge 25" x 3-1/4"	27 05 28
Cable Management Solutions	CM301-TS-2 CM301-TS-4	Snake Canyon Bridge Support 29-1/2" x 1" or 53-1/2" x 1"	27 05 28
Contractor Selected		Miscellaneous Hardware	27 05 28
27 05 53 – Identification for Communications Systems			

Manufacturer	Part Number	Description	Section Reference
U.G. Products Co., Inc.	100W	White Plastic Tag, 2" x 2-1/2"	27 05 53
Brady	PSL-514-619	Machine Printed Label	27 05 53
Brady	WML-1223-292	Machine Printed Label	27 05 53
Brady	CL-111-619	Machine Printed Label	27 05 53
Brady	PSL-1833-619-BK	Machine Printed Label	27 05 53
Contractor Selected		Miscellaneous Hardware	27 05 53
27 11 16 – Communications Cabinets, Racks, Frames, and Enclosures			
Belden	XDR-8419-310N	84" Relay Rack, #10-32 Tapped, 3" Channel	27 11 16
Belden	XDR-9619-310W	96" Relay Rack, #10-32 Tapped, 3" Channel	27 11 16
Belden	9714-0190	Horizontal Rack Busbar	27 11 16
Belden	9016-1921-3	19" Deep Low Profile Shelf, Black	27 11 16
Panduit	PZRFE4U	Raised Floor Enclosure, 22.62" high x 22.62" wide x 5" deep	27 11 16
Panduit	PZRFC	Raised Floor Enclosure Cover	27 11 16
CPI	A0622-RF	2U + 2U Raised Floor Enclosure, 25-1/2" wide x 25-1/2 long x 4-3/4" deep	27 11 16
Contractor Selected		Miscellaneous Hardware	27 11 16
27 11 19 – Communications Termination Blocks and Patch Panels			
Belden	RVAPPF1U24BK	10GX REVConnect Patch Panel, 24-port, 1U, Black	27 11 19
Belden	RVAPPF2U48BK	10GX REVConnect Patch Panel, 48-port, 2U, Black	27 11 19
Belden	ECX-01U	Fiber Express Panel, 1U Rack Mount	27 11 19
Belden	ECX-04U	Fiber Express Panel, 4U Rack Mount	27 11 19
Belden	FF4X06LD	Fiber Frame OM4, 12 Fiber, LC Duplex	27 11 19
Belden	FF4X12LD	Fiber Frame OM4, 24 Fiber, LC Duplex	27 11 19
Belden	FFSX06LD	Fiber Frame OS2, 12 Fiber, LC Duplex	27 11 19
Belden	FFSX12LD	Fiber Frame OS2, 24 Fiber, LC Duplex	27 11 19
Belden	RVAXCTK96CBK	REVConnect Wall-Mount Termination Kit Coupler 96-Port	27 11 19
Belden	RVUCADM	REVConnect Wall-Mount Cable Dressing Module	27 11 19
Belden	RVUPCMC	REVConnect Wall-Mount Patch Cable Management Channel	27 11 19
Belden	RVUHOCK	REVConnect Wall-Mount Horizontal Channel Kit	27 11 19

Manufacturer	Part Number	Description	Section Reference
Belden	10GXS12XXA1000 (XXX=Color)	10GXS Small-Diameter Cables, UTP 4-Pair, 23 AWG, Riser-CMR	27 11 19
Contractor Selected		Miscellaneous Hardware	27 11 19
27 11 23 – Communications Cable Management and			
CPI/Belden	10250-718/BLRS250-18B	Universal Cable Runway, 18" W	27 11 23
CPI/Belden	12100-712/BLRRD100-12B	Cable Runway Radius Drop, 12"	27 11 23
CPI/Belden	12100-718/BLRRD100-18B	Cable Runway Radius Drop, 18"	27 11 23
CPI/Belden	10595-712/BLRTR595-9B	3" Channel Mounting Plate, 12"	27 11 23
CPI/Belden	10595-718/BLRTR595-15B	3" Channel Mounting Plate, 18"	27 11 23
CPI/Belden	11421-712/BLWAS421-12B	Wall Mounting Angle, 12"	27 11 23
CPI/Belden	11421-718/BLWAS421-18B	Wall Mounting Angle, 18"	27 11 23
CPI/Belden	10608-001/BLVBS489-0UB	Vertical Wall Bracket	27 11 23
CPI/Belden	11309-001/BLFK309-01B	Cable Runway Foot	27 11 23
CPI/Belden	11301-011/BLBSU301-15B	Butt Splice Kit	27 11 23
CPI/Belden	11746-712/BLTSB746-12B	Triangular Support Bracket, 12"	27 11 23
CPI/Belden	11746-718/BLTSB746-18B	Triangular Support Bracket, 18"	27 11 23
CPI/Belden	12594-701/BLJSU302-15B	Runway Enclosure Junction Kit	27 11 23
CPI/Belden	12595-701/BLRTR595-12B	Runway Enclosure Junction Kit	27 11 23
CPI/Belden	10506-702/BLREK506-02B	Runway Elevation Kit	27 11 23
CPI/Belden	10506-706/BLREK506-04B	Runway Elevation Kit	27 11 23

Manufacturer	Part Number	Description	Section Reference
CPI/Belden	11959-715/BLREK506-06B	Runway Elevation Kit	27 11 23
CPI/Belden	10596-706/BLCRP596-06B	Cable Runway Retaining Post	27 11 23
CPI/Belden	13392-712/BLDU-05B	Cable Runway Pathway Divider	27 11 23
CPI/Belden	10642-001/BLPEC642-002	Protective End Cap	27 11 23
Contractor Selected		Miscellaneous Hardware	27 11 23
27 13 13 – Communications Copper Backbone Cabling			
Belden	IBDN25P 0081000	25-pair IBDN Plus Category 5e, Plenum Rated	27 13 13
Belden	IBDN25R 0081000	25-pair IBDN Plus Category 5e, Non-Plenum Rated	27 13 13
Contractor Selected		Miscellaneous Hardware	27 13 13
27 13 23 – Communications Optical Fiber Backbone Cabling			
Belden	FI4D002P9	Distribution Plenum Series, UL OFNP/CSA FT6, Multimode OM4, 50 µm, 2 fibers	27 13 23
Belden	FI4D006P9	Distribution Plenum Series, UL OFNP/CSA FT6, Multimode OM4, 50 µm, 6 fibers	27 13 23
Belden	FI4D012P9	Distribution Plenum Series, UL OFNP/CSA FT6, Multimode OM4, 50 µm, 12 fibers	27 13 23
Belden	FD4D012P9	Distribution Plenum Series, Indoor/Outdoor, UV Rated, UL OFNP/CSA FT6, Multimode OM4, 50 µm, 12 fibers	27 13 23
Belden	FI4D024P9	Distribution Plenum Series, UL OFNP/CSA FT6, Multimode OM4, 50 µm, 24 fibers	27 13 23
Belden	FI4D048PK	Distribution Plenum Series, UL OFNP/CSA FT6, Multimode OM4, 50 µm, 48 fibers	27 13 23
Belden	FISD006P9	Distribution Plenum Series, UL OFNP/CSA FT6, Single mode Enhanced OS2, 6 fibers	27 13 23
Belden	FISD012P9	Distribution Plenum Series, UL OFNP/CSA FT6, Single mode Enhanced OS2, 12 fibers	27 13 23
Belden	FISD024P9	Distribution Plenum Series, UL OFNP/CSA FT6, Single mode Enhanced OS2, 24 fibers	27 13 23
Belden	FI4D002R9	Distribution Riser Series, UL OFNR/CSA FT4, Multimode OM4, 50 µm, 2 fibers	27 13 23

Manufacturer	Part Number	Description	Section Reference
Belden	FI4D006R9	Distribution Riser Series, UL OFNR/CSA FT4, Multimode OM4, 50 µm, 6 fibers	27 13 23
Belden	FI4D012R9	Distribution Riser Series, UL OFNR/CSA FT4, Multimode OM4, 50 µm, 12 fibers	27 13 23
Belden	FI4D024R9	Distribution Riser Series, UL OFNR/CSA FT4, Multimode OM4, 50 µm, 24 fibers	27 13 23
Belden	FI4D048PK	Distribution Riser Series, UL OFNR/CSA FT4, Multimode OM4, 50 µm, 48 fibers	27 13 23
Belden	FI4D006F9	Industrial Armored (Aluminum Interlock), Tight Buffer, UL OFCR/CSA FT4, Multimode OM4, 50 µm, 6 fibers	27 13 23
Belden	FI4D012F9	Industrial Armored (Aluminum Interlock), Tight Buffer, UL OFCR/CSA FT4, Multimode OM4, 50 µm, 12 fibers	27 13 23
Belden	FI4D024F9	Industrial Armored (Aluminum Interlock), Tight Buffer, UL OFCR/CSA FT4, Multimode OM4, 50 µm, 24 fibers (Single jacket)	27 13 23
Belden	FI4D006A9	Industrial Armored (Aluminum Interlock), Tight Buffer, UL OFCP/CSA FT6, Multimode OM4, 50 µm, 6 fibers	27 13 23
Belden	FI4D012A9	Industrial Armored (Aluminum Interlock), Tight Buffer, UL OFCP/CSA FT6, Multimode OM4, 50 µm, 12 fibers	27 13 23
Belden	FI4D024A9	Industrial Armored (Aluminum Interlock), Tight Buffer, UL OFCP/CSA FT6, Multimode OM4, 50 µm, 24 fibers (Single jacket)	27 13 23
Pyramid	PLM100T	Indoor Corrugated Innerduct, Plenum Rated	27 13 23
Carlson	14108R	Indoor Corrugated Innerduct, Non-Plenum Rated	27 13 23
Contractor Selected		Miscellaneous Hardware	27 13 23
27 15 13 – Communications Copper/Optical Fiber Horizontal Cabling			
Belden	10GXS13	10GXS Small Diameter, Nonbonded-Pair, 4-Pair, 23 AWG, Plenum-CMP, Category 6A (white)	27 15 13
Belden	10GXS13	10GXS Small Diameter, Nonbonded-Pair, \$-Pair, 23 AWG, Plenum-CMP, Category 6A (black)	27 15 13
Contractor Selected		Miscellaneous Hardware	27 15 13

Manufacturer	Part Number	Description	Section Reference
27 15 43 – Communications Faceplates and Connectors			
Belden	AX102277	10GX Modular Jack, Category 6A MDVO-Style (TIA 606 Blue)	27 15 43
Belden	RVAMJKUTB-B24	10GX Modular Jack, Category 6A REVConnect Style (TIA 606 Blue)	27 15 43
Belden	AX105696-BK	LC Duplex, OM3 (Aqua Adapter) MDVO-Style Fiber Modules	27 15 43
Belden	FT4LC900FS01	LC-Multimode, OM4 Fiber Optic Connector – Splice-On	27 15 43
Belden	FTSLC900FS01	LC-Singlemode, OS2 Fiber Optic Connector – Splice-On	27 16 43
Belden	FF4X12LD	ECX Fiber Frame OM4 12 Fiber LC	27 15 43
Belden	A0643207	Multimedia Outlet MDVO, 6-Port, International White	27 15 43
Belden	AX106512-EW	Multimedia Outlet KeyConnect, 6-Port Electrical White	27 15 43
Belden	AX100221	Multimedia Outlet MDVO, 24-Port, International White	27 15 43
Belden	A0405538	Blank Insert MDVO, International White	27 15 43
Belden	A0405257	Flush Faceplate, 1-Port MDVO, International White	27 15 43
Belden	AX101433	Flush Faceplate, 2-Port MDVO, International White (former A0405261)	27 15 43
Belden	AX101437	Flush Faceplate, 3-Port MDVO, International White (former A0405266)	27 15 43
Belden	AX101437	Flush Faceplate, 4-Port MDVO, International White (former A0405290)	27 15 43
Belden	A0407073	Modular Furniture Faceplate MDVO, 3-Port, International White	27 15 43
Suttle	SE630ABC6-52	Wall Mount Telephone Outlet, 6C6P	27 15 43
Contractor Selected		Miscellaneous Hardware	27 15 43
27 16 19 – Communications Patch Cords, Station Cords, and Cross-Connect Wires			
Belden	CA21106004	10GX Patch Cord, Bonded-Pair, 4-Pair, 24AWG Solid, T568A/B, CMR (4ft)	27 16 19
Belden	CA21106007	10GX Patch Cord, Bonded-Pair, 4-Pair, 24AWG Solid, T568A/B, CMR (7ft)	27 16 19
Belden	CA21106010	10GX Patch Cord, Bonded-Pair, 4-Pair, 24AWG Solid, T568A/B, CMR (10ft)	27 16 19

Manufacturer	Part Number	Description	Section Reference
Belden	CA21106015	10GX Patch Cord, Bonded-Pair, 4-Pair, 24AWG Solid, T568A/B, CMR (15ft)	27 16 19
Belden	CA21106025	10GX Patch Cord, Bonded-Pair, 4-Pair, 24AWG Solid, T568A/B, CMR (25ft)	27 16 19
27 54 00 – CATV (Community Antenna Television) System			
Belden	1189AP	CATV Video, RG6, 18 AWG BCCS, Quad Shield, Plenum	27 54 00
Belden	1322R	CATV Video, RG6, 18 AWG BCCS, Quad Shield, CMR	27 54 00
Contractor Selected		Miscellaneous Hardware	27 54 00

PART 3 – EXECUTION

3.1 PROJECT CONDITIONS

- A. The Contractor shall convert and integrate existing in-service communications infrastructure into new and existing spaces in close coordination with the Owner. The Contractor shall accommodate all Owner requirements for after-hours scheduling and planned service outages.
- B. Remove and dispose of communications cabling and other physical support elements, such as racks and panels, as required by construction phasing.
- C. The Owner shall not be responsible for delays in work because of shutdowns due to Contractors' unsafe working practices. Delays enforced by the Safety Office caused by unforeseen environmental conditions in the work area may be out of the Contractor's control. Contractors shall contact the Owner's primary project manager immediately if delays are incurred for safety reasons.
- D. Activities in all buildings are critical to the objectives of the Owner. These objectives shall not be interrupted by the Contractor's work activities. The active information transport system and cabling associated with specific work beyond the construction area shall not be disrupted at any time. Unusual circumstances (e.g. voice cutovers) can occur and shall be declared and scheduled with as much notice as possible. Service disruptions, if needed, shall be at the convenience and schedule of the Owner.
- E. The Owner's police department controls security in work areas. Officers have final authority over access and security.
- F. Contractor shall clean work areas daily and remove debris legally and adequately from the Owner's property.
- G. Materials and supplies stored in the project shall be neatly stacked outside the circulation areas. All exits and paths shall be cleaned to prevent dirt from being tracked into the Owner's facilities.
- H. The Contractor shall ensure that all building fixtures are reinstalled in their original condition after the final shift of the day.
- I. Contractors may require parking spaces to be cordoned off before work to access maintenance holes, hand holes, hand boxes, utility poles, and underground spaces and pathways. Contractors shall contact the Owner to arrange this.

- J. The Contractor shall be responsible for securing any parking permits before the first day of work on-site.
- K. Work outside of regular Owner operating hours and days shall be coordinated with the Owner.

3.2 DIMENSIONS AND DEFINITE LOCATIONS

- A. The Project Drawings depicting work show approximate locations. The exact location of equipment and devices shall be established in the field per the Owner's instructions. Consideration shall be given to construction features, equipment of other trades, and requirements of the equipment proper.
- B. The Contractor shall refer to shop and submittal drawings for all equipment requiring electrical connections to verify rough-in and connection locations.
- C. Unless expressly stated, no drawing by scale shall be used as a dimension for work. Dimensions noted on the drawings are subject, in each case, to measurements of adjacent or previously completed work, and all necessary measurements shall be taken before undertaking any work dependent upon them.

3.3 PROGRESSIVE AND FINAL CLEANING

- A. Rubbish resulting from work shall be removed and disposed of daily.
- B. The Contractor shall clean wall, floor, and ceiling surfaces, furniture, equipment, casework, and other surfaces made dirty by construction work.
- C. Telecommunications Rooms (TR) and entrance facilities shall be free of rubbish for the duration of the project. The floor shall be swept at project completion.
- D. Where painted surfaces of equipment have been damaged or rusted during construction, the Contractor shall prepare surface(s) and paint to match the final finish.
- E. Aesthetics of existing architecture and finishes shall be maintained to the Owner's satisfaction.
- F. Unless otherwise specified, new conduit, raceway, fittings, supports, and enclosures shall be finished to match the color of the wall/ceiling surface on which the mounts were exposed to the public view and as determined by the Owner.
- G. Existing conduit and raceway that is used under the project and which is marked up by the Contractor shall be finished to match the color of the wall/ceiling surface on which it mounted where exposed to the public's view and as requested by the Owner
- H. The Contractor shall thoroughly clean all assemblies within all EF, MC, and TR spaces before turning them over to the Owner for operation. Cleaning shall include, but not be limited to, all cable runways, racks, and wire managers (inside and out), as well as copper and optical fiber panels (inside and out). Should the MC or TR be completed before the balance of the floor space it serves, racks, cabinets, and wall frames shall be covered with plastic sheeting to repel dust and other contaminants to which they will be subjected.

3.4 WARRANTY

- A. The Contractors shall adhere to all warranty requirements for all installations.
- B. The Contractor shall submit, in the bid documents, any additional Contractor-specific warranties

or guarantees to be offered on the project.

- C. The Contractor shall supply all necessary documentation to process and record the warranty(s) and verify the installation solution.
- D. Warranty of Fitness for a Particular Purpose
 - 1. The Contractor shall warrant recognition and understanding of all Owner requirements and intended uses for the Division 27 systems, warrant the response to the bidding process, and warrant the equipment and all other products and services to satisfy all requirements identified in the contract documents as fit for the intended use unless specifically identified, in writing, in the bid response.
- E. Warranty of Title
 - 1. The Contractor shall warrant the equipment and software license rights title to be free and clear of all liens, encumbrances, or agreements. The Contractor further warrants and represents that in the event of any claim at any time, the Contractor shall pay, satisfy, or make provision for the payment and satisfaction of any claim of any nature for the Owner shipping of any equipment.
- F. System Warranty
 - 1. The entire installation shall be warranted for two (25) years from the date of final acceptance for all components, parts, assemblies, and workmanship. It shall include a twenty (20) year application assurance warranty as a manufacturer-registered system installation. During the warranty period, and for non-conformities, the Contractor has notice that the Contractor shall take all necessary and appropriate action, free of charge, to correct any non-conformity with the warranties contained in the manufacturer agreement. During the warranty period, the Contractor shall provide the Owner, free of costs and charges, with all support necessary to ensure that the cabling system meets the requirements specified in this document and the performance guarantees provided by the Contractor. During the warranty period, Contractors shall furnish, or cause to be furnished, all maintenance, service, parts, and replacements necessary to maintain the cabling system in good working condition at no cost to the Owner.
 - 2. All deficiencies shall be corrected within forty-eight (48) hours.
- G. The Contractor shall supply a full manufacturer's application assurance warranty for all new installations, including approved termination hardware and cabling media from the proposed manufacturer's list of approved materials. Services to be provided by this Contractor to the Owner during the warranty period shall include, without limitation, the following.
 - 1. Remedial Maintenance
 - a. The Contractor shall provide service on the Owner's site as necessary, including fault isolation, diagnosis, and repair.
 - 2. Maintenance Records
 - a. The Contractor shall maintain a current record of the cabling system configuration, including maintenance history and all additions, moves, and changes, at the job site.
 - 3. Replacement Parts
 - a. Contractor shall provide and install replacement parts, including new components, to replace faulty cabling system components.
 - 4. Field Change Orders
 - a. The Contractor shall provide and install field change orders with the Owner's approval. The General Contractor or construction manager shall process all change order requests.
 - 5. Post-System Warranty Maintenance Service
 - a. Option of Maintenance Service
 - 1) The Owner reserves the right to elect or cancel any maintenance service the Contractor provides at any time.
 - b. Warranty of On-Site Response
 - 1) Regardless of the cause of the problem, the Contractor shall ensure that parts,

equipment, and materials are available to remedy the problems and that its personnel are ready to begin work (such action being deemed a "response") within the contract periods for the applicable warranty period or maintenance period.

6. Warranty of Security

- a. Contractor shall warrant that its personnel, including all Subcontractors, shall at all times comply with all Owner security regulations of which the Owner has informed the Contractor of. The Contractor also warrants that it has obtained all necessary licenses and permits required by federal, state, and local governments.

3.5 SAFETY REQUIREMENTS

- A. All contract work shall be performed according to the policies, procedures, and standards established by the Owner's Safety Department.
- B. The Owner's safety officers have final authority over working conditions, required permits, and required equipment and its proper use. Contractors shall be responsible for coordinating their activities with the Safety Office.
- C. In construction areas, all Contractor personnel shall wear personnel protection devices as deemed appropriate by the General Contractor or Construction Manager and as required by OSHA for the work location and operation. Devices shall include but are not limited to, hard hats, work boots, safety eye protection, reflective vests, etc.
- D. All exposed holes, pits, pipes, etc., either inside or outside the Owner's facilities, shall be barricaded or plated and adequately secured when Contractor personnel are not present. All ladders, hanging wires, pipes, and other items protruding at a pedestrian-level travelway must be removed or secured following the final shift of the day.
- E. During breaks or when only a portion of work has been completed, tools shall not be left exposed where others may risk injury or attempt to use them. Windows and doors shall not be left unsecured or propped open during breaks. After the final shift each day, doors, windows, or other openings shall be adequately secured.
- F. Contractors shall provide the most stringent traffic control as specified by the State of Missouri, as well as signage, etc., as needed to maintain a safe working environment. All work area access, road closures, parking space closures, and work outside of the normal Owner's operating hours and days shall be coordinated by Contractors as far in advance as possible with the Owner. The Owner shall determine if closures of roads or spaces are possible at proposed dates and times. Work at any location may be restricted by day or time, depending on the area's location, the need for road closures/traffic control, and concurrent events in the area or on campus. Contractors should contact the Owner well in advance to determine how to schedule access to work areas.
- G. When driving on the Owner's property, Contractor personnel shall observe all traffic safety regulations and pay particular attention to pedestrians. All loose material and debris on vehicles shall be adequately secured and tied down.

3.6 PERSONNEL IDENTIFICATION

- A. All Contractor personnel working on the project shall carry a valid company identification card and wear clothing that identifies their company name. This requirement shall be in effect throughout the project.
- B. Contractor personnel may be required to wear Owner-issued identification badges when performing work on the Owner's facilities. If required, the Contractor shall provide the names and social security numbers of all personnel assigned to the project to prepare badges. Upon project completion, Owner-issued badges shall be returned to the Owner.

END OF SECTION 270000

SECTION 27 05 00
COMMUNICATIONS - COMMON WORK RESULTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, Division 07, and Division 08 Specification Sections, apply to this Section.
- B. Drawings and provisions of the Contract, including Division 26 Electrical.
- C. Section 27 0000 – Communications General
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1123 – Communications Cable Management and Cable Runway
- J. Section 27 1313 – Communications Copper Backbone Cabling
- K. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- L. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- M. Section 27 1543 – Communications Faceplates and Connectors
- N. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- O. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODE AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SUMMARY

- A. This Section includes:
 - 1. Hangers and Supports for Communications Systems
 - 2. Conduits and Back Boxes for Communications Systems
 - 3. Cable Trays for Communications Systems
 - 4. Surface Raceways for Communications Systems
 - 5. Cable Routing, Separation, and Distance
 - 6. Communications Room Provisions

- 7. Common Installation Requirements
- 8. Fire-stopping

B. All references to Division 26, contained herein, are the responsibility of the Electrical Contractor.

1.4 DEFINITIONS

A. Refer to Section 270000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

A. Refer to Section 270000 – Communications General

1.6 COORDINATION WITH OTHER TRADES

- A. Coordinate layout of work with other trades. Make minor adjustments in the location required for coordination. Locations of structural systems, heating work, and plumbing lines shall be preferred over locations of conduit lines where conflict occurs. Structural systems, heating work, and plumbing lines shall not interfere with or otherwise impede the routing of communication cabling with cable trays, raceways, or other pathways dedicated to communications. All potential issues shall be brought to the attention of the General Contractor or Construction Manager immediately before proceeding with installation.
- B. Minor adjustments other than those that are minor shall be submitted to the General Contractor or Construction Manager for approval before proceeding with the work.
- C. Coordinate locations, arrangement, mounting, and support of all communications provisions with Division 26.
 - 1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 - 2. To provide ease of disconnecting the equipment with minimum interference to other installations.
 - 3. To allow right of way for piping and conduit installed at the required slope.
 - 4. So that connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and the working and access space of other equipment.
- D. Coordinate the installation of the required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- E. Coordinate sleeve selection and application with selection and application of fire-stopping specified in Division 07 and Division 26
- F. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08.
- G. The location of TO(s) and WAO(s) shown on the Drawings is approximate, and the General Contractor or Construction Manager shall have the right to relocate any TO(s) or WAO(s) before they are installed without additional cost.

1.7 REFERENCES

- A. ASTM E 84 - Test Method for Surface Burning Characteristics of Building Materials.
- B. ASTM E 119 - Method for Fire Tests of Building Construction and Materials.

- C. ASTM E 814 - Standard Method of Fire Tests of Through-Penetration Firestops.
- D. Underwriters Laboratories (UL) - UL723 - Standard Test for Surface Burning Characteristics of Building Materials.
- E. Underwriters Laboratories (UL) - UL1479.
- F. Published Fire-Rated Assemblies: Underwriters Laboratories (UL) of Northbrook, IL, runs ASTM E814 under its designation of UL1479 and publishes the results in its "Fire Resistance Directory," which is updated annually with a mid-year supplement.
- G. Underwriters Laboratories (UL) Fire Resistance Directory, 1997, Volumes 1 and 2. NOTE: For information on ordering Underwriters Laboratories Fire Resistance Directory, 1997.

1.8 SYSTEM PERFORMANCE REQUIREMENTS

- A. General: Provide fire-stopping systems that are produced and installed to resist the spread of fire, according to requirements indicated and the passage of smoke and other gases.
- B. F-Rated Through-Penetration Firestop Systems: Provide through-penetration firestop systems with F ratings indicated, as determined per ASTM E 814, but not less than that, equaling or exceeding the fire-resistance rating of the constructions penetrated.
- C. Fire-Resistive Joint Sealants: Provide joint sealants with indicated fire-resistance ratings, as determined per ASTM E 119, but not less than equaling or exceeding the fire-resistance rating of the construction where the joint occurs.
- D. For fire-stopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate under these conditions.
- E. For fire-stopping exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined per ASTM E 84

1.9 SUBMITTALS

- A. Refer to Section 270000 – Communications General
- B. Product Data Sheets
- C. Certification by the fire-stopping manufacturer that products comply with local regulations controlling volatile organic compounds (VOCs) and are nontoxic to building occupants.
- D. Shop drawings detailing materials, installation methods, relationships to adjoining construction for each through-penetration firestop system, and each kind of construction condition penetrated and penetrating item.
- E. Submit documentation, including illustrations, from a qualified testing and inspecting agency that applies to each through-penetration firestop configuration for construction and penetrating items.
- F. Where Project conditions require modification of qualified testing and inspecting agency's illustration to suit a particular through-penetration firestop condition, submit an illustration approved by the fire-stopping manufacturer's fire protection Architect with modifications marked.
- G. Qualification data for firms and persons specified in Paragraph 1.6 to demonstrate their capabilities and experience

1.10 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Provide fire-stopping that complies with the following requirements and those specified under Paragraph 1.4.
- B. Fire-stopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspection agency is UL, Warnock Hersey, or another agency performing testing and follow-up inspection services for firestop systems that are acceptable to authorities having jurisdiction.
- C. Through-penetration firestop systems are identical to those tested per ASTM E 814 under conditions where a positive furnace pressure differential of at least 0.01 inch of water is maintained at a distance of 0.78 inch below the fill materials surrounding the penetrating items in the test assembly. Provide rated systems complying with the following requirements:
- D. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
- E. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by UL in their "Fire Resistance Directory," by Warnock Hersey, ICBO Evaluation Report or by another qualified testing and inspecting agency.
- F. Information on drawings referring to specific design designations of through-penetration firestop systems is intended to establish requirements for performance based on conditions that are expected to exist during installation. Any changes in conditions and designated systems require the Owner's and Architect's prior approval. Submit documentation showing that the performance of proposed substitutions equals or exceeds that of the systems they would replace and are acceptable to authorities having jurisdiction.
- G. Installer Qualifications: Engage an experienced Installer who has completed fire-stopping similar in material, design, and extent to that indicated for the Project and who has performed successfully.
- H. Single-Source Responsibility: Obtain through-penetration firestop systems for each kind of penetration and construction condition indicated by a single manufacturer.
- I. Provide fire-stopping products containing no detectable asbestos as determined by the method specified in 40 CFR Part 763, Subpart F, Appendix A, Section 1, "Polarized Light Microscopy."
- J. Coordinating Work: Coordinate construction of openings and penetrating items to ensure that designated through-penetration firestop systems are installed per specified requirements.
- K. Pre-installation Conference: Conduct a conference at the Project site to inform those making penetrations of fire-stopping practices to ensure maintaining penetration hole sizes to comply with the firestop system requirements

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fire-stopping products to the Project site in original, unopened containers or packages with intact and legible manufacturer's labels identifying project and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at the job site.

- C. Store and handle fire-stopping materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, or other causes.
- D. Comply with recommended procedures, precautions or remedies described in Material Safety Data Sheets as applicable.
- E. Do not use damaged or expired materials

1.12 ENVIRONMENTAL REQUIREMENTS

- A. Do not install fire-stopping when ambient or substrate temperatures are outside limits permitted by fire-stopping manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Maintain this minimum temperature before, during, and 3 days after the installation of materials.
- C. Ventilate fire-stopping per fire-stopping manufacturers' instructions by natural means or, where this is inadequate, forced air circulation.
- D. During installation, provide masking and drop cloths to prevent fire-stopping materials from contaminating adjacent surfaces.
- E. Do not use materials that contain flammable solvents

1.13 SEQUENCING

- A. Sequence Work to permit fire-stopping materials to be installed after adjacent and surrounding work is complete.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Hangers and Supports
 - 1. Cooper B-Line
 - 2. Erico/Caddy
 - 3. Panduit Corporation
- B. Fire-stopping Products
 - 1. 3M Fire Protection Products
 - 2. Dow Corning
 - 3. Hilti Construction Chemicals, Inc.
 - 4. The RectorSeal Corporation

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified

2.3 HANGERS AND SUPPORTS

- A. Product selection shall be subject to Part 3 installation requirements.

2.4 CONDUITS AND BACK BOXES

- A. Refer to Division 26.

2.5 CABLE TRAYS – BUILDING

- A. Refer to Division 26.

2.6 CABLE TRAYS – COMMUNICATIONS SPACES

- A. Refer to Section 271123 – Communications Cable Management and Cable Runway

2.7 SURFACE RACEWAYS

- A. Refer to Division 26.

2.8 SLEEVES FOR RACEWAYS AND CABLES

- A. Refer to Division 26.

2.9 SLEEVE SEALS

- A. Refer to Division 26.

2.10 GROUT

- A. Refer to Division 26.

2.11 PLYWOOD

- A. All walls must be covered with ¾" Grade A-C plywood, sanded smooth, and painted with fire-resistant paint (not fire-retardant plywood unless local fire codes require it).
- B. The plywood should be mounted vertically starting at 2" AFF and secured to the walls using flush-mounted fasteners designed and listed to secure wood to the specific wall/stud material.
- C. All plywood must be mounted in contact with one another with no gaps between sheets. All fasteners must be flush with the surface of the plywood.

2.12 CONDUIT CHASE PIPES

- A. Conduit Chase Pipes shall be provided within TR spaces where ceiling tile has been provided and must be breached.
 - 1. All conduits must include pull strings or mule tape.
- B. Electrical Metallic Tubing (EMT) and Fittings
 - 1. 4" trade size
 - a. Manufactured to ANSI C80.3 (EMT Zinc Coated)
 - b. UL Standard 797 (EMT – Steel)
- C. Refer to Division 26.

- D. 4" Conduit shall tie the EF to the TRs, ERs, and MC.
 - 1. All conduits must include pull strings or mule tape.

2.13 FIRE-STOPPING

- A. Provide fire-stopping composed of components compatible with each other, the substrates forming openings, and the items penetrating the fire-stopping under conditions of application and service, as demonstrated by fire-stopping manufacturer based on testing and field experience.
- B. Provide components for each fire-stopping system that are needed to install fill materials and to comply with Paragraph 1.4. Use only components specified by the fire-stopping manufacturer and approved by the qualified testing and inspecting agency for the designated fire-resistance-rated systems. Accessories include but are not limited to the following items:
 - 1. Semi-refractory fiber (mineral wool) insulation.
 - 2. Ceramic fiber.
 - 3. Sealants are combined with other forming/damming materials to prevent leakage of fill materials in a liquid state.
 - 4. Fire-rated formboard.
 - 5. Joint fillers for joint sealants.
- C. Permanent forming/damming/backing materials, including the following:
 - 1. Semi-refractory fiber (mineral wool) insulation.
 - 2. Ceramic fiber.
 - 3. Sealants are combined with other forming/damming materials to prevent leakage of fill materials in a liquid state.
 - 4. Fire-rated formboard.
 - 5. Joint fillers for joint sealants.
- D. Temporary forming materials
- E. Substrate primers
- F. Collars
- G. Steel sleeves

PART 3 – EXECUTION

3.1 FIELD CONDITIONS

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other components for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.
- B. Unless otherwise noted, the footage for cabling and materials shown on the Project Drawings are based upon available plant records, Architectural drawings, or the Architect's route and pathway assumptions. The Contractor shall be required to perform field surveys and measurements before ordering materials.

3.2 HANGERS AND SUPPORTS

- A. Communications cabling shall be contained within a combination of open spaces, enclosed conduits, raceways, and cable trays. These pathways are designed to provide the capacity to install high-performance communications cabling for present and future applications properly.
- B. Where cabling is installed within a conduit, cable trays, and raceways, pathways shall be furnished and installed by Division 26.

- C. Where conduit, cable trays, or raceways are not provided, Division 27 shall install independent supports so that no cable rests directly on the ceiling tile, mechanical ductwork, or other supporting structures.
 - D. Cables shall be neatly routed and bundled above the suspended ceiling structure in bundles limited to the number of cables per manufacturer specifications and installation practices for Category 6a UTP or F/UTP as applicable to the installed media. High-performance sling-type supports shall be used for adds/moves/changes or pathways with low cable counts. High-performance J-Hook supports shall also be used.
 - E. Suspended ceiling support wires shall not be used for cabling support. Cables shall not be laid directly on ceiling tiles or rails. Cables placed in hangers in the ceiling area shall be routed high and away from all other electrical and mechanical systems to avoid contact with light fixtures, ventilation ducts, sprinkler systems or plumbing piping, motors, or any other electrical devices.
 - F. The maximum separation between support points for all cabling shall be five (5) feet.
 - G. When applicable, the manufacturer shall certify all cable pathway support elements for a high-performance twisted pair installation. Support products, including optical fiber, shall be approved for supporting Category 6a (10 Gigabit) or higher cables.
- 3.3 CONDUITS AND BACK BOXES
- A. Refer to Division 26
- 3.4 CABLE TRAYS – BUILDING
- A. Refer to Division 26
- 3.5 CABLE TRAYS – COMMUNICATIONS SPACES
- A. Refer to Sections 271123 and 271844 – Communications Cable Management and Cable Runway

3.6 SURFACE RACEWAYS

- A. Refer to Division 26

3.7 SLEEVES FOR RACEWAYS AND CABLES

- A. Refer to Division 26

3.8 SLEEVE SEALS

- A. Refer to Division 26

3.9 GROUT

- A. Refer to Division 26

3.10 COMMON INSTALLATION REQUIREMENTS

- A. Measure the indicated mounting heights at the bottom of the unit for suspended items and at the unit's center for wall mounted items.
- B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom consistent with these requirements.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of electrical equipment components and other nearby installations. Connect to facilitate future disconnecting with minimum interference with other items in the vicinity.
- D. Right of Way: Give to piping systems installed at a required slope.
- E. The Contractor shall contact Owner before the commencement of work and coordinate with Owner personnel and all other trades. The general contractor or construction manager shall coordinate the commencement of work.

3.11 CABLE ROUTING, SEPARATION, AND DISTANCE

- A. Whenever possible, primary cable routing paths shall follow the logical structure of the building. When a wall must be breached, provide sleeved openings. Cabling shall enter and exit these areas at 90° angles. Route all cables and cable raceways parallel or perpendicular to the building structure. No diagonal runs shall be permitted unless noted otherwise.
- B. To reduce or eliminate the field effect of EMI on data signaling, cable runs shall be kept a minimum distance from EMI sources. Refer to ANSI/NECA/BICSI-568-2006 Standard for Installing Commercial Building Telecommunications Cabling.
 - 1. Minimum separation distance from possible sources of EMI:
 - a. 5 inches (125mm) from power lines of 2 KVA or less.
 - b. 12 inches (305mm) from lighting fixtures.

- c. Minimum separation distance from possible sources of EMI exceeding 5KVA:

Condition	Min. Separation Distance
Unshielded power lines or electrical equipment in proximity to open or non-metal pathways.	24 in. (610 mm)
Unshielded power lines or electrical equipment near a grounded metal conduit pathway.	12 in. (300 mm)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal conduit pathway.	6 in. (150 mm)
Electrical motors and transformers.	47 in. (1200 mm)

- C. Communications cabling shall not be run parallel to any high-voltage electrical wiring.
- D. The maximum length of horizontal communications cables shall be limited to 90 meters from the TO (Telecommunications Outlet) to the point of termination within the TR.
- E. All cabling shall be installed as single continuous homerun pulls from the Connector Block to the Patch Panel. No inline connectors or splices in any form shall be permitted.
- F. Cable routing from the Cable Runway onto the distribution frame shall be neatly organized and supported by cable support brackets, clips, loops, radius drops, spools, etc., as required to minimize tension and stress on the connector block terminations.

3.12 COMMUNICATIONS ROOM PROVISIONS

A. PLYWOOD BACKBOARDS

1. Furnish and install plywood backboards on all useable walls where indicated on Project Drawings.
2. Plywood shall be AC Grade or better, void-free.
3. Mount plywood to cover the entire area where Cable Runway, equipment, terminating hardware, and cable management rings may be mounted.
4. Securely fasten plywood to wall framing members. Use flush hardware and support to mount plywood. Ensure that the strength and placement of the hardware are sufficient to handle the total anticipated load (static and dynamic) and equipment mounting.
5. All Plywood surfaces shall be painted with two coats of fire retardant paint in light gray or a color matching the room's color.

B. CONDUIT CHASE PIPES

1. Furnish and install 4" EMT conduit "Chase Pipes" within the TR and other information transport system spaces where communications cabling must pass through suspended ceiling tiles to the point of cabling termination.
2. Chase Pipes shall be securely mounted to the wall above Cable Runway segments using slotted Unistrut and 4" pipe clamps. Reamed and bush pipes at both ends prior to cabling rough-in.
3. Chase Pipes shall tie the EF to the TRs, ERs, and MCs.

3.13 FIRE-STOPPING

- A. Refer to Division 07, Section "Penetration Fire-stopping".
- B. Refer to Division 26
- C. Verify that openings are ready to receive the Work of this Section.

- D. All conduits, sleeves, and penetrations of fire-rated walls into which communications cables are pulled or reserved for communications cables shall be sealed with an approved fire-retardant method and materials per UL (Underwriters Laboratory Inc.) Fire Resistance Directory.
- E. All openings provided, whether filled, partially filled, or unused, shall be fire-stopped after cabling has been installed.
- F. Preparation
 - 1. Surface Cleaning: Clean out openings and joints immediately before installing fire-stopping to comply with the recommendations of the fire-stopping manufacturer and the following requirements:
 - a. Remove all foreign materials from surfaces of opening and joint substrates and from penetrating items that could interfere with the adhesion of fire-stopping.
 - b. Clean opening and joint substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bonds with fire-stopping. Remove loose particles from the cleaning operation.
 - c. Remove laitance and form release agents from concrete.
 - 2. Priming: Prime substrates were recommended by the fire-stopping manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
 - 3. Masking Tape: Use masking tape to prevent fire-stopping from contacting adjoining surfaces that will remain exposed upon completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-stopping materials. Remove the tape as soon as possible without disturbing fire-stopping's seal with substrates.
 - 4. Do not reuse the existing fire-stopping materials that do not meet all requirements of Section 07270. In particular, the existing putty within the annulus of conduit sleeves must be removed through walls and floors where the putty was manufactured by RectorSeal Corporation and dated before 50697. This is typical of most locations where the putty is encountered. If uncertain, contact the Owner for the approximate date of installation of putty.
- G. Installing Through-Penetration Firestops
 - 1. Regulatory Requirements: Install penetration seal materials per published "Through-Penetration Firestop Systems" in UL's Fire Resistance Directory.
 - 2. General: Comply with the System Performance Requirements (Paragraph 1.4) and the through-penetration firestop manufacturer's installation instructions and drawings about products and applications indicated.
 - 3. Install forming/damming materials and other accessories of types required to support fill materials during their application and in the position needed to produce the cross-sectional shapes and depths required to achieve fire ratings of designated through-penetration firestop systems. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
 - 4. Install fill materials for through-penetration firestop systems by proven techniques to produce the following results:
 - 5. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items.
 - 6. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 7. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces flush with adjoining finishes.
- H. Field Quality Control
 - 1. Where deficiencies are found, repair or replace fire-stopping so that it complies with requirements.
 - 2. Keep areas of work accessible until inspection by applicable code authorities.

3. Perform under this Section, patching and repairing fire-stopping caused by cutting or penetrating by other trades.
- I. Adjusting and Cleaning
 1. Remove equipment, materials, and debris, leaving the area undamaged and clean.
 2. Neatly cut and trim materials as required.
 3. As work progresses, clean off excess fill materials and sealants adjacent to openings and joints using methods and cleaning materials approved by manufacturers of fire-stopping products and products in which openings and joints occur.
 - J. PROTECTION OF FINISHED WORK
 1. Protect fire-stopping during and after the curing period from contact with contaminating substances or form damage resulting from construction operations or other causes so that they are without deterioration or damage at the time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated fire-stopping immediately and install new materials to produce fire-stopping complying with specified requirements.

END OF SECTION 27 05 00

SECTION 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS

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
- B. Section 27 00 00 – Communications General
- C. Section 27 05 00 – Common Work Results for Communications
- D. Section 27 05 28 – Pathways for Communications
- E. Section 27 05 53 – Identification for Communications Systems
- F. Section 27 11 16 – Communications Cabinets, Racks, Frames, and Enclosures
- G. Section 27 11 19 – Communications Termination Blocks and Patch Panels
- H. Section 27 11 23 – Communications Cable Management and Cable Runway
- I. Section 27 13 13 – Communications Copper Backbone Cabling
- J. Section 27 1 323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 15 13 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 15 43 – Communications Faceplates and Connectors
- M. Section 27 16 19 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 32 23 – Voice Communications Elevator Telephones

1.2 CODE AND STANDARDS

- A. Refer to Section 27 00 00 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SUMMARY

- A. This Section includes a solid grounding of technology systems and equipment. It includes basic requirements for grounding to protect life, equipment circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.
- B. Comply with the ANSI/TIA/EIA Standard 607, "Grounding and Bonding Requirements," and the NEC.

1.4 SUBMITTALS

- A. Refer to Section 27 00 00 – Communications General.
- B. Submit product data for the following:
 - 1. TMGB busbar
 - 2. TGB busbar
 - 3. Equipment rack busbars
 - 4. Two-hole and one-hole lugs
 - 5. No. 3/0 AWG and No. 6 AWG conductors
- C. Field-testing organization certificates, signed by the Contractor, certifying that the organization performing field tests complies with the requirements specified in Quality Assurance below.
- D. Report of field tests and observations certified by the testing organization.

1.5 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of electrical connectors, terminals, and fittings of types and rating required, and ancillary grounding materials, including stranded cable, copper braid and bus, ground rods, and plate electrodes, whose products have been in satisfactory use in similar service for not less than three years.
- B. Installer: Qualified with at least 3 years of successful installation experience on projects with technology groundwork similar to that required for this project.
- C. Listing and labeling: Provide products specified in this Section that are listed and labeled. The terms “listed” and “labeled” shall be defined as they are in the National Electric Code, Article 100.
- D. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” (NRTL) as defined in OSHA Regulation 1910.7.
- E. Field-testing Organization Qualifications: To qualify for acceptance, the independent testing organization must demonstrate, based on the evaluation of organization-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct the testing indicated satisfactorily.
- F. Component Standard: Components and installation shall comply with NFPA 70, “National Electric Code” (NEC).
- G. UL Compliance: Comply with applicable requirements of UL Standards Nos. 467 and 869 pertaining to electrical and electronic grounding.
- H. IEEE Compliance: Comply with applicable requirements of IEEE Standard 142 and 241 pertaining to electrical and electronic grounding.

1.6 BONDING & GROUNDING INFRASTRUCTURE

- A. IC (Interconnecting Bonding Conductor) (referred to in TIA/EIA-607 as the Bonding Conductor for Telecommunications): The copper conductor that bonds the TMGB to the service equipment (power) ground.
- B. TMGB (Telecommunications Main Grounding Busbar): A copper ground reference busbar, typically installed in the entrance facility or entrance room, and is bonded to the service equipment (power) ground by the Interconnecting Bonding Conductor.
- C. TGB (Telecommunications Grounding Busbar): A copper ground reference busbar, typically

installed in telecommunication closets (TR) and is bonded to the TMGB by the TBB. The TGB references metallic entities in the TR space to ground.

- D. TBB (Telecommunications Bonding Backbone): An insulated copper conductor extending from the TMGB to each TGB.
- E. EK (Equipment Bonding Conductor): An insulated copper conductor that bonds metallic items and equipment to the TMGB and TGB

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Subject to compliance with requirements, provide products by the following:
 - 1. Burndy Corp.
 - 2. Crouse-Hinds Co.
 - 3. Electrical Components Division; Gould Inc.
 - 4. General Electric Supply Co.
 - 5. ILSCO
 - 6. Newton Instrument Company
 - 7. Panduit Corporation
 - 8. Thomas and Betts Corp.

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. The bidder shall confirm that all reference part numbers listed within Division 27 are current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 COMPONENTS

- A. Telecommunication Main Grounding Busbar (TMGB): 1/4" x 4"x 20" insulated copper ground bar.
- B. Telecommunication Grounding Busbar (TGB): 1/4" x 4" x 10" insulated copper ground bar.
- C. Equipment Rack Busbars: 1/4" x 1" x 19" rack ground bar detail for equipment rack applications.
- D. Other Ground Reference Busbars: 1/4" x 1" x 12" insulated copper bar for miscellaneous applications.
- E. Bare annealed copper bars of the rectangular cross-section. All bus bars shall be two-hole lug type.

2.4 CONDUCTORS

- A. Bonding Conductors: All bonding conductors shall be green-insulated copper with a minimum of 98% conductivity. The exception is the use of flat, braided, aluminum ground straps utilized for bonding sections of aluminum cable trays.
- B. Unless otherwise specified, size the conductors as required by NEC.

- C. Unless otherwise specified, the IC (Interconnecting Bonding Conductor) (referred to in TIA/EIA-607 as the Bonding Conductor for Telecommunications) shall be black insulated copper, No. 3/0 AWG with green tape applied.
- D. Unless otherwise specified, the TBB (Telecommunications Bonding Backbone) shall be black insulated, copper, No. 3/0 AWG with green tape applied..
- E. Unless otherwise specified, the EK (Equipment Bonding Conductor) shall be green insulated copper, No. 6 AWG.
- F. Grounding Electrode Conductor: Stranded cable.
- G. Bare Copper Conductors:
 - 1. Conform to the following:
 - a. Solid Conductors: ASTM B-3.
 - b. Assembly of Stranded Conductors: ASTM B-8.
 - c. Tinned conductors: ASTM B-33.
- H. Coordinate with Division 26 Sections.

2.5 MISCELLANEOUS CONDUCTORS

- A. Flexible Jumper Strap: Flexible flat conductor, 480 strands of 30-gauge bare copper wire, 3/4" wide, 9-1/2" long; 48.250cm. Protect braid with copper bolt-hole ends with holes sized for 3/8" diameter bolts.

2.6 CONNECTOR PRODUCTS

- A. Listed and labeled as grounding connectors for materials used and approved by a nationally recognized testing laboratory.
- B. Two-hole compression lugs: Long-barrel type color code blue, high conductivity wrought copper, electro-tin plated, or approved equal.
- C. One-hole compression lugs: Long-barrel one-hole lugs color code blue, high conductivity wrought copper, electro tin plated, or approved equal.
- D. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs, and clamps as manufacturers recommend for indicated applications.
- E. Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, and bonding straps as recommended accessories by manufacturers.
- F. Pressure Connectors: High-conductivity-plated units.
- G. Bolted Clamps: Heavy-duty units listed for the application.
- H. Copper compression HTAP & clear cover
- I. Cabinet-Mounted Front-to-Rail Jumper
- J. Paint-piercing bonding screw
- K. Paint-piercing grounding washer

- L. Two-hole ESD kits
- M. Thread-forming screws

PART 3 – EXECUTION

3.1 INSPECTION

- A. The Contractor must examine the areas and conditions under which technology grounding connections are to be made and notify the Architect in writing of conditions detrimental to the proper completion of work. Do not proceed with work until unsatisfactory conditions have been corrected acceptably.

3.2 PREPARATION

- A. Site and materials preparation for testing is the responsibility of the Contractor.

3.3 INSTALLATION

- A. All local bonding is provided in the telecommunications rooms, equipment rooms, and entrance facilities as specified on the drawings and specifications.
- B. Ground electrical systems and equipment as required by code, utility, local ordinances, and requirements.
- C. Cable connections and joints shall be provided per ANSI/TIA/EIA-607.
- D. Bonding conductors should be continuous and routed directly to the termination point.
- E. All insulated ground bars must be isolated from the structural support by a 2" minimum separation, using the manufacturer's recommended insulating stand-offs and hardware.
- F. Clean ground bars before terminating conductors.
- G. Label all telecommunications bonding conductors as close to their termination point.
- H. Bond the TMGB to the service equipment (power) ground, typically located in the electrical entrance facility, utilizing the most direct route possible to minimize conductor length.
- I. Bond all TGBs to the TMGB using the specified conductor size.
- J. Whenever two or more TBBs are used in a multi-story building, they shall be bonded together on the top floor and on every third floor, at a minimum, using the bonding conductor size specified. Refer to drawings.
- K. Bond the following to the TMGB when present:
 - 1. Telecommunication panelboards: Alternating Current Equipment Ground Bus (ACEG), if equipped, or its enclosure.
 - 2. Building structural steel, if exposed (steel rebar of reinforced concrete is not required to be bonded).
 - 3. Metallic equipment racks
 - 4. Cable Shields.
 - 5. All metal raceways and cable trays for telecommunications cabling extend from the same room or space where the TMGB is located.
 - 6. Others as identified on the Drawings.

L Bond the following to the TGB when present:

1. Telecommunication panelboards: ACEG, if equipped, or its enclosure.
2. TGBs within the same space
3. TBBs terminated on the same floor to other TGBs
4. Metallic equipment racks
5. Cable Shields.
6. All metal raceways and cable trays for telecommunications cabling extend from the same room or space where the TGB is located.
7. Others as identified on the Drawings.

M. Conductors

1. Within each communications space EF, MC, TR, Data Center, Demarc Room, and any other information transport systems distribution space, the Contractor shall provide and install an individual homerun of green insulated stranded 6AWG copper ground wire directly from the TGB or TMGB to each assembly as follows:
 - a. Rack or Cabinet
 - b. Cable Runway Assembly
 - c. BET (Building Entrance Terminal)
 - d. Wall and Rack Mounted Frame
 - e. Owner-furnished Network Electronics Unit, if directed
 - f. Shielded Patch Panel
 - g. Primary Protector
 - h. Secondary Protector
2. Route conductors on short, direct paths that have minimum resistive and inductive impedance as follows:
 - a. Bonding conductors shall be routed with minimum bends or changes in direction
 - b. Bonding connections shall be made directly to the points being bonded.
 - c. Do not bend the grounding conductor wires into tight angles. Changes in direction shall be of the widest radius possible.
 - d. Unnecessary connections or splices in bonding conductors shall be avoided.
 - e. When absolutely necessary, use an approved connection and position it in an accessible location.

N. Connections

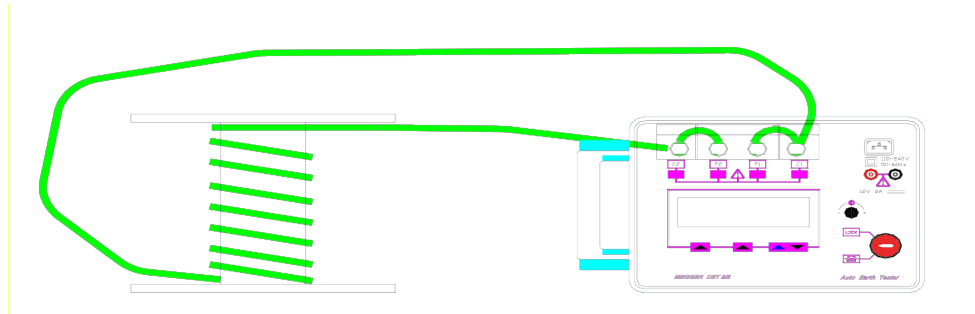
1. IC and TBB conductors shall be terminated at the TMGB and TGB with two-hole compression lugs.
2. EK bonding conductors shall be terminated with one-hole compression lugs.
3. Make connections in such a manner as to minimize the possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
4. Use electroplated or hot-tin-coated materials to ensure high conductivity and move contact points closer to the order of the galvanic series.
5. Make connections with clean bare metal at points of contact.
6. Coat and seal connections involving dissimilar metals with inert material, such as red lead paint, to prevent future moisture penetration to contact surfaces.
7. Tighten grounding and bonding connectors and terminals, including screws and bolts, per the manufacturer's published torque tightening values for connectors and bolts. Where the manufacturer's torque requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.

3.4 TESTING PROCEDURES AND GUIDELINES

A. Tests to be Performed

1. The following tests shall be performed. Multiple steps are necessary for each test. Refer to the "Testing" Section.

2. Perform the Biddle Meter Resistance Test.
3. Record test lead resistance on the datasheet.
4. Disconnect the test lead from Terminal C1 ONLY. The test lead should remain connected to Terminal C2 if possible, throughout the tests

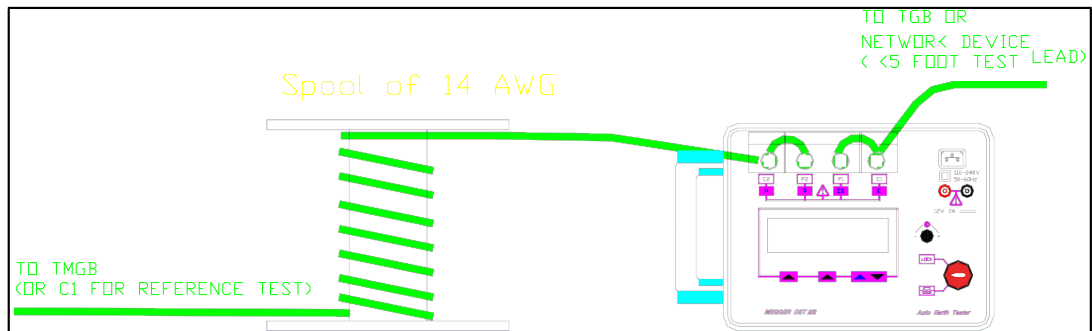


C. Ground Reference System Continuity Test

1. The ground reference system shall be tested to validate the continuity and integrity of the interconnection of the TMGB, TGB, TBB, IC, and building's grounding electrode.

D. Ground Reference System Continuity Test Procedure

1. Refer to the figure below:



Remove all equipment bonding conductors (EKxxx) from the TMGB and the TGBs. THE IC SHALL REMAIN ATTACHED TO THE TMGB. Panelboard and building steel bonds shall be removed. The TBB conductor (interconnecting the TMGB and TGBs) shall remain attached at all busbars.

2. Move the meter and test lead to the first TGB to be tested. Route the test lead to the TMGB and connect the test lead to the TMGB. The other end of the test lead should still be connected to Terminal C2 from the Reference Test. Connect a short test lead (typically from the manufacturer) from Terminal C1 to the TGB to be tested.
3. Perform the Biddle Meter Resistance Test.
4. Record the resistance on the datasheet.
5. Attach the equipment bonding conductor from the panelboard (if the panelboard is located within the room) to the TGB and repeat the test. Record the resistance on the datasheet. The reading may be slightly less than the first reading.
6. Attach the equipment bonding conductor from the building steel (if applicable) and repeat the test. Record the resistance on the datasheet. The reading may be slightly less than the previous reading.

TEST RESULT DATASHEET			
Project Name:		Crew Members:	
Test Date:			

Test Used:				Service Current (High/Low):			
				Filter (On/Off):			
				Frequency (Hz):			
TGB Identification:				Reference Test Resistance (W):			
Ground Reference Continuity Test Data							
TGB		TGB Panelboard Ground		TGB with Panelboard and Building Steel Ground			
Reference	Test (Difference)	Reference	Test (Difference)	Reference	Test (Difference)		

7. This completes the grounding system continuity test for this TGB. Leave the building steel and panelboard ground connected to this TGB. Repeat the test for all other TGBs.
8. The test results should be in the order of a few 10ths of an ohm (approximately 0.10 to 0.90). The measured value should decrease when adding the panelboard and building steel grounds.

E. Wire and Cable Documentation

1. The Test Results Data Sheet shall be completed and submitted to the Owner before substantial completion of the Project.
2. The Test Results Data Sheet shall be used to record and submit all test data. All information shall be typed on the sheet.
3. Provide the Owner with a Test Results Data Sheet for each TGB. Make copies of the form as necessary.

3.6 WIRE AND CABLE IDENTIFICATION

- A. Furnish and install labels as identified in Specification Section 270553 Identification for Communication Systems.

END OF SECTION 27 05 26

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0553 – Identification for Communications Systems
- F. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- G. Section 27 1119 – Communications Termination Blocks and Patch Panels
- H. Section 27 1123 – Communications Cable Management and Cable Runway
- I. Section 27 1313 – Communications Copper Backbone Cabling
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract
- C. NFPA 70 – National Electrical Code.
- D. ASTM B633 – Specification for Electrodeposited Zinc Coatings on Iron and Steel.
- E. ASTM A510 – Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel.
- F. NEMA VE 2-2000 – Cable Tray Installation Guidelines.
- G. ASTM A123 - Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes.
- H. NEMA VE 1-1998 - Metallic Cable Tray Systems

1.3 DEFINITIONS

- A. Refer to Section 270000 – Communications General

1.4 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 270000 – Communications General

1.5 SYSTEM DESCRIPTION

- A. This Section includes secure support from the building structure for technology items using cable trays, hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.
- B. All support shall utilize threaded fasteners for all technology/attachments.
 - 1. Exception: Spring steel fasteners may be used instead of threaded fasteners only for $\frac{3}{4}$ " raceways above suspended ceilings.
- C. Types of support anchors, sleeves, and seals specified in this section include the following:
- D. Cable basket
 - 1. Clevis hangers
 - 2. Riser clamps
 - 3. C-clamps
 - 4. I-beam clamps
 - 5. Conduit straps
 - 6. Round steel rods
 - 7. Lead expansion anchors
 - 8. Toggle belts
 - 9. Floor seals
- E. Supports, anchors, sleeves, and seals furnished as part of factory-fabricated equipment are specified as part of that equipment assembly or as specified in Division 26.
- F. Wire basket support systems are defined to include but are not limited to, straight sections of continuous wire mesh, field-formed horizontal and vertical bends, tees, dropouts, supports, and accessories.
- G. Ladder-style cable tray systems are separately defined within Section 271123 Communications Cable Management and Cable Runway.
- H. The work covered under this section includes furnishing all necessary coordination, labor, supervision, materials, equipment, tests, and services required to install complete cable basket systems within all areas, as indicated within project Drawings.

1.6 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of supporting devices of types, sizes, and ratings required, whose products have been in satisfactory use in similar service for not less than three years.
- B. Contractor Qualifications: The firm shall have at least three years of successful installation experience with projects utilizing electronic/electrical supporting device work similar to that required for this project. NEC Compliance: Comply with NEC requirements as applicable to the construction and installation of supporting devices.

- C. MSS Compliance: Comply with applicable MSS standard requirements of fabrication and installation practices for pipe hangers and supports.
 - D. UL Compliance: Provide components that are UL-listed and labeled.
 - E. FS Compliance: Comply with Federal Specification FF-S-760 about retaining straps for conduit, pipe, and cable.
 - F. Components shall be listed and labeled by ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.
 - G. Comply with NEC, as applicable to constructing and installing cable tray and cable channel systems (Article 392).
 - H. Comply with NFPA 70B, "Recommended Practice for Electrical Equipment Maintenance," about installing cable tray systems.
 - I. Installer: Qualified with at least three years of successful installation experience on projects with technology raceway work similar to that required for this project
 - J. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA), and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.
- 1.7 SUBMITTALS
- A. Refer to Section 270000 – Communications General
 - B. Submit the following per the Conditions of Contract and Supplementary Conditions Specifications Sections.
 - 1. Product Data: Submit manufacturer's data on supporting devices, including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.
 - 2. Where multiple products are shown on one cut sheet, circle the product to be used.
 - 3. Shop Drawings: Submit dimensioned drawings of fabricated products, indicating details of fabrication and materials.
 - 4. Submit drawings of cable tray (wire basket) and accessories, including connector assemblies, clamp assemblies, brackets, splice plates, splice bars, waterfalls, grounding clamps, and hold-down plates showing accurately scaled components. Show layout, support, and installation details.
 - 5. Submit the manufacturer's data on the cable tray (wire basket) support system, including, but not limited to, types, materials, finishes, dimensions, colors, and inside depths.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Cable Management Solutions, Inc. – Series 301 (Snake Canyon)
- B. CPI (Chatsworth Products Inc.) – On-Trac Wire Mesh Cable Tray System
- C. Cooper/B-Line - FlexTray
- D. Legrand – Cablofil

- E. Panduit Corporation - GridRunner

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 -Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 SECTIONS AND COMPONENTS

- A. Provide a cable tray (wire basket) of the indicated types and sizes, with connector assemblies, clamp assemblies, connector plates, splice plates, and splice bars. Construct units with rounded edges and smooth surfaces per applicable standards and with the following additional construction features.
- B. Material and finish specifications for each metal cable tray type are as follows:
 - 1. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be electro-plated zinc per ASTM B633.
 - 2. Straight sections shall be made from steel meeting the minimum mechanical properties of ASTM A510 and shall be coated after the wire basket runway has been fabricated by ASTM A123 (CSA Type 1). All hot-dip galvanized sections must be returned to the point of manufacture after coating for inspection and removal of all icicles and excess zinc. Failure to do so may damage cables and injure installers.
 - 3. Electro-Galvanized Zinc: Support accessories and miscellaneous hardware shall be coated per ASTM B633 SC3, and threaded components shall be coated per ASTM B633 SC1.

2.4 CABLE TRAY AND SUPPORT SYSTEMS

- A. The wire basket shall be made of high-strength steel wires and formed into a standard 2 inch by 4-inch wire mesh pattern with intersecting wires welded together. All wire ends along the wire basket sides (flanges) shall be rounded during manufacturing for the safety of cables and installers.
- B. Wire basket cable tray shall conform to the following nominal criteria.
 - 1. Straight sections shall be furnished in standard lengths.
 - 2. The wire basket shall have a 6-inch usable loading depth according to the width identified in the drawings.
 - 3. All fittings shall be field-formed as needed.
 - 4. The installation and fittings of all raceways shall allow Category 6a cable and fiber optic cable to be pulled in and through without exceeding the pulling tension or minimum bending radius.
 - 5. All splicing assemblies shall be the bolted type using flange locknuts.
 - 6. Cable tray supports shall be center support hangers, trapeze hangers, or wall brackets supported by 1/4-inch or 3/8-inch diameter rods.
 - 7. Special accessories shall be furnished to protect, support, and install all cable tray support systems.
- C. Reference: Section 270000 Communications General, Part 2 –Products.

PART 3 – EXECUTION

3.1 GENERAL

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other components for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.

3.2 DELIVERY, STORAGE, AND HANDLING

- A. Deliver cable tray (wire basket) support systems and components carefully to avoid breakage, bending, and scoring finishes. Do not install damaged equipment.
- B. Store cable tray (wire basket) and accessories in original cartons and clean dry space; protect from weather and construction traffic

3.3 INSTALLATION

- A. Install cable tray (wire basket) where indicated; in accordance with recognized industry practices (NEMA VE-2 2000), ensure that the cable tray equipment complies with requirements of the NEC and all general installation practices.
- B. Coordinate cable tray (wire basket) with other electrical and mechanical work as necessary to properly interface raceway installation with other work.
- C. Provide sufficient space encompassing the cable tray (wire basket) to permit access to install and maintain cables.
- D. Install all raceways parallel to the wall or ceiling lines unless otherwise noted. Support basket cable raceways every 4' minimum and 6" from ends or boxes.
- E. Ground the raceway per NEC Article 250, 392 and ANSI/TIA/EIA-607.
- F. Route raceways in a manner to avoid steam, water, or other liquid piping.
- G. Fish or blow through every run of conduit before plastering to guard against obstructions or omissions and plug ends carefully with tight fitting wood plugs or bush caps to avoid filling with plaster, dust, etc. and to avoid the possibility of condensation.
- H. Leave nylon or steel fish wire in all raceways where permanent wiring is not being installed under this contract.
- I. Install conduit making the total cross-sectional area of each raceway of sufficient size to permit ready installation or withdrawal of the cables required therein.
- J. Route cable tray (wire basket) with a minimum of 5" clearance from fluorescent light fixtures, 12" clearance from electrically operated equipment, and all wiring at 120 or more volts and four feet from transformers or large motors.
- K. All technology conduits must be provided with nylon bushings for cable pulling without damage.
 - 1. All conduits must include pull strings or mule tape.
- L. For cable support, provide strain relief a minimum of every 10' in vertical conduits runs. Provide the proposed method and products as a product submittal.

- M. In areas without suspended ceilings, install cable tray (wire basket) raceways 6" below the lowest obstruction unless otherwise directed.

3.4 TESTING

- A. Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:
 - 1. Expansion anchors.
 - 2. Toggle bolts.
 - 3. Powder-driven threaded studs.
- B. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain and submit the Structural Architect's signed approval before transmitting loads to the structure. Test the fastener's rated proof load to 90 percent. If the fastening fails the test, revise all similar fastener installations and retest until satisfactory results are achieved.
- C. Test cable tray (wire basket) support systems to ensure electrical continuity of bonding and grounding connections and to demonstrate compliance with specified maximum grounding resistance.
- D. The manufacturer shall provide test reports witnessed by an independent testing laboratory of the "worst case" loading conditions outlined in this specification and performed per the latest revision of NEMA VE-1

END OF SECTION 27 05 28

SECTION 27 05 53
IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- G. Section 27 1119 – Communications Termination Blocks and Patch Panels
- H. Section 27 1123 – Communications Cable Management and Cable Runway
- I. Section 27 1313 – Communications Copper Backbone Cabling
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SCOPE OF WORK

- A. Provide, furnish, and install all materials and equipment and provide all labels required as shown on the drawings, schedules, and specified in all Sections of Division 27.
- B. The specifications, drawings, and schedules intend for labels to be legible and provided in readily visible locations.
- C. Only those items affected by the installation of the Project shall be labeled unless otherwise indicated.
- D. Comply with the EIA/TIA Standard 606, "The Administration Standard for the Telecommunications Infrastructure OF Commercial Buildings."

- E. This Section includes requirements for identification of components including, but not limited to, the following:
 - 1. Identification labeling for cables and conductors: the labeling system shall designate the cables' origin and destination and assign them a unique identifier.
 - 2. Equipment labels, including racks, cabinets, ground bars, and panels; racks and patch panels shall be labeled to identify the location within the cable system infrastructure.
 - 3. All labeling information shall be recorded on the as-built drawings, and all test documents shall reflect the appropriate labeling scheme.
 - 4. Operational signs.
 - F. The Contractor shall submit, for confirmation and approval by the Owner and Architect, all details of the labeling system for the cable installation per details included with this document. The Owner will confirm the exact phrasing of the labeling scheme with the successful Contractor.
 - G. All label printing shall be machine generated using indelible ink ribbons or cartridges. Self-laminating labels shall be used on cable jackets, appropriately sized to the OD of the cable, and placed within view at the termination point on each end. Outlet, patch panel, and wiring block labels shall be installed on or in the space provided on the device.
- 1.4 SUBMITTALS
- A. Refer to Section 270000 – Communications General and General Provisions of the Contract
 - B. Product Data Sheets for the Labeling Machine to be used

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden
- B. Panduit
- C. Brady
- D. U.G. Products Company

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. Bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified

PART 3 – EXECUTION

3.1 GENERAL

- A. Unless otherwise indicated, the exact location of labels shall be established in the field per instructions from the Owner. Consideration shall be given to construction features, label placement as affected by other work by other Crafts, and label placement to provide maximum

benefit and minimum obstruction of physical equipment and hardware features.

- B. The Contractor shall keep a detailed, up-to-date record of the label information and placement of all labels installed as specified herein.
- C. The Contractor shall fill in the label information in the form (17111A.xls) provided by the Owner. The information requested is typically that which can only be provided after installation.
- D. The Contractor shall furnish and install the manufacturer's standard products of categories and types required for each application.
- E. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in technology identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as approved in submittals and as required by standards.
- F. The Contractor shall clean all surfaces prior to the attachment of labels. Follow the manufacturer's recommendations for cleaning and affixing labels.
- G. Sequence of work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work.
- H. Apply cable/conductor identification on each cable/conductor in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used on shop drawings, contract documents, and similar previously established identification for project's technology work.

3.2 SPACES

A. Entrance Facility (EF)

- 1. The Contractor is not required to do any work. Others shall provide the room label.

B. Telecommunications Room (TR)

- 1. The Contractor is not required to do any work. Others shall provide the room label.

3.3 CABLING

A. Copper Cabling

1. Campus Copper cable (CC)

- a. CC is outside plant multi-pair copper cable.
- b. Label Location: The label is visible on the cable at both ends, near the hardware on which the cable is terminated.
- c. Label Information: The cable identifier is the letters CC followed by the cable number (5 numeric characters) and the Cable Count (5 numeric characters), both the beginning and end count. The cable identifier is unique to the Campus and shown on the Drawings.
- d. Method: White plastic tag with the printed Brady label affixed to the lower portion of the tag. The tag shall be fastened to the cable with a nylon cable tie.
- e. Tag part number: U.G. Products Co. Inc., white plastic, 2" x 2-1/2", No.100W
- f. Brady label part number: PSL-514-619
- g. Format: All capital letters. The font should be as large as possible to fill the label space with the information. It should be Helvetica or equal and bold. The format is two-line with the cable identifier on the top line and the Node Pair Count below. Center text—use a dash as a delimiter.
- h. Example: CC00001 08251-08350

2. Copper Tie Cable

- a. The Copper Tie Cable is a multi-pair cable that extends between the existing MDF and the new frame in the Entrance Facility. It is an interior cable. The cable is either hard-punched onto the existing protectors or terminated on new frames at both ends. The cable will be considered a Building Copper cable and shall be assigned the MDF's Node Pair Count.
- b. Label Location: On the cable at both ends, near the hardware on which the cable is terminated.
- c. Label Information: Refer to the labeling detail at the end of this section. The cable labeling is unique to each cable throughout the campus.
- d. Method: White plastic tag with the printed Brady label affixed to the lower portion of the tag. The tag shall be fastened to the cable with a nylon cable tie.
- e. Tag part number: U.G. Products Co. Inc., white plastic, 2" x 2-1/2", No.100W
- f. Brady label part number: PSL-514-619
- g. Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format with the Cable identifier first and the Cable Count last

3. Building Copper cable (BC)

- a. BC is an interior multi-pair copper backbone cable extending from the Main cross-connect (MC) to the Telecommunications Room (TR) or Intermediate cross-connect (ICC).
- b. Label Location: On the cable at both ends, near the hardware on which the cable is terminated.
- c. Label Information: Refer to the labeling detail at the end of this section. The cable labeling is unique to each cable throughout the campus.
- d. Method: White plastic tag with the printed Brady label affixed to the lower portion of the tag. The tag shall be fastened to the cable with a nylon cable tie.
- e. Tag part number: U.G. Products Co. Inc., white plastic, 2" x 2-1/2", No.100W
- f. Brady label part number: PSL-514-619
- g. Format: All capital letters. The font should be as large as possible to fill the label holder space with the information. It should be Helvetica or equal and bold. The format should be one line with the Cable identifier first and the Cable Count last.
- h. Example: 82CB1C-0001-0200

B. Fiber Cabling

1. Building Fiber Cable (BF)

- a. BF is interior fiber backbone cable extending from the Main Cross-connect (MC) to the Telecommunications Room (TR) or Intermediate Cross-connect (ICC).
- b. Label Location: On the jacket or sheath of the cable at both ends (before the fan-out or breakout point). Place the label near the cable entrance into the termination hardware and exterior to the termination hardware.
- c. Label Information: Refer to the labeling detail at the end of this section. The cable labeling is unique to each cable throughout the campus.
- d. Method: Machine printed Brady Labels.
- e. Brady label part number: WML-1223-292
- f. Format: All capital letters. Font should be as large as possible to fill the label space with the information. The font should be Helvetica or equal and bold. One line format with the Cable identifier first and the Cable Count last. Example: 82MB1C-A001-024

3.4 TERMINATION HARDWARE

- A. See drawings for examples of frame layout and labeling.

B. Copper Termination Hardware

1. Outlet faceplate

- a. The outlet faceplate is typically the BELDEN MDVO faceplate.

- b. Label Location: Refer to outlet configuration drawings.
 - c. Label Information: Refer to the labeling detail at the end of this section.
 - d. Method: Print the information on an adhesive label and affix the label as shown on outlet configuration drawings—machine-printed Brady Labels.
 - e. Brady label part number: CL-111-619
 - f. Format: The font should be sized to fill the area of the strip. It should be Helvetica or equal and bold, one-line format.
 - g. Example: 82D1E-A01
- 2. Multi-pair Copper Backbone Cables on Wiring Blocks
 - a. The Campus Copper and Building Copper Backbone cables are terminated on BIX Blocks.
 - b. Label Location: Between the labeling holding tabs mounted in the center of each 50 pair termination field of the BIX Mounts.
 - c. Label Information: Cable Count in 5-pair increments.
 - d. Method: Color-coded plastic strips from BELDEN/CDT-IBDN. Use the Brady software program to print the information on the strip or manufacturer's preprinted labels.
 - e. Format: The font should be sized to be readable and fit all information required without text overlap. The font should be Helvetica or an equal, one-line format.
 - f. Example: (Riser Count) [00301 00305] [00306 00310] [00311 00315] [00316 00320] [00321 00325]
- 3. Station Cables on BIX Blocks
 - a. The voice station cables are terminated on the BIX Blocks.
 - b. Label Location: Between the labeling holding tabs mounted in the center of each 50-pair termination field of the BIX Mounts.
 - c. Label Information: Refer to Drawings. Each strip labels 12 jack positions.
 - d. Method: Blue-colored plastic strips from BELDEN. Use Brady's software program to print the information on the strip.
 - e. Format: The font should be sized to fill the vertical space on the strip. It should be Helvetica or equal and bold, one-line format, centered over each 4-pair group.
 - f. Example: Refer to Drawings
- 4. Patch Panel (for data station cables)
 - a. The data station cables are terminated on the BIX patch panels.
 - b. Label Location: Label the patch panel on the end of each patch panel mounted in an equipment rack. The adhesive label is affixed to the face of the patch panel.
 - c. Label Information: Refer to Drawings. Refer to the labeling detail at the end of this section.
 - d. Method: Machine-printed Brady Labels.
 - e. Brady label part number: PSL-1833-619-BK.
 - f. Format: The font should be sized to fill the vertical space on the strip. It should be Helvetica or equal and bold, one-line format.
 - g. Example: 82D1E-A

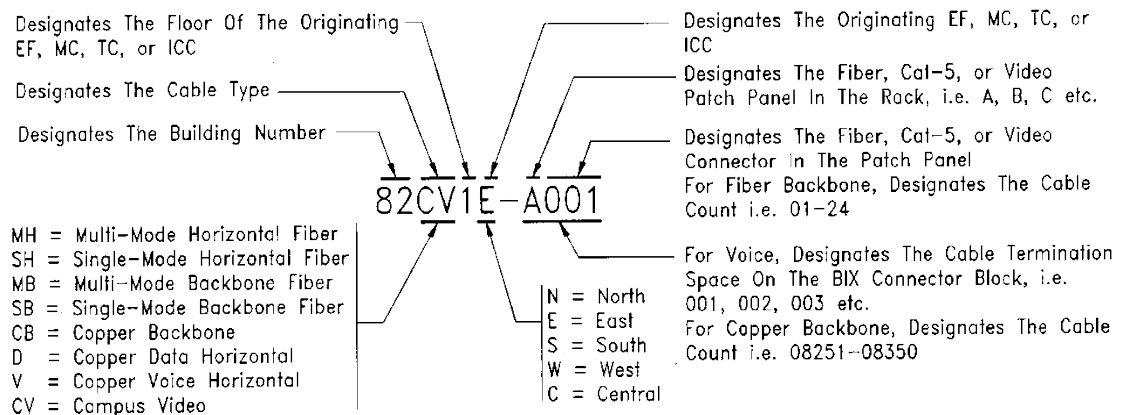
C. Fiber Termination Hardware

- 1. Item: Fiber Panel enclosures
 - a. The optical fiber cables are terminated on BIX Rack Mount Patch Panels
 - b. Label Location: On the lower center outside of the enclosure and on the inside frame, lower center.
 - c. Label Information: Refer to Drawings. Refer to the labeling detail at the end of this section
 - d. Method: Machine-printed Brady Labels.
 - e. Brady label part number: PSL-1833-619-BK
 - f. Format: The font should be sized to fill the label space with the information. The font should be Helvetica or equal and bold, one line format.
 - g. Example: 82SB1C-A

D. Fiber Terminations

1. Building Fiber terminations

- The connector layout within each enclosure may vary. Generally, the columns of fiber connectors are grouped in units of six. Columns count from left to right. Termination positions within a column count from top to bottom. The connector adapters are both simplex SC and ST
- Label Location: The rack-mounted fiber termination units are factory labeled inside the front enclosure on the panels. Refer to the Outlet Configuration drawings for locations on outlets.
- Label Information: Refer to Drawings. Refer to the labeling detail at the end of this section.
- Method: Factory labeled at fiber termination units. At workstation outlets, Print the information on an adhesive label and affix the label as shown on outlet configuration drawings. Machine-printed Brady Labels.
- Brady label part number: CL-111-619
- Format: The font should be sized to fill the label space with information without overlapping the next column. It should be Helvetica or equal and bold, one-line format.
- Example: Refer to Labeling Detail and Outlet Configuration Drawings.



PATCH PANEL, CABLE, & OUTLET LABELING DETAIL

3.5 EQUIPMENT AND EQUIPMENT RACKS

A. Equipment Racks

- The equipment racks are typically 19" wall-mount or free-standing racks.
- Label Location: On the crossbar at the top of the rack, on both sides of free-standing racks.
Label Information: The Equipment Rack identifier is the letter R followed by the rack number (2 numeric characters). The Equipment Rack label information is shown on the drawing details. The Equipment Rack identifier is unique to the room.
- Method: Machine-printed Brady Labels
- Brady Label part number: PSL-514-619
- Format: All capital letters. The font should be sized to fill the label space with the information. It should be Helvetica or equal and bold, one-line format.
- Example: R01

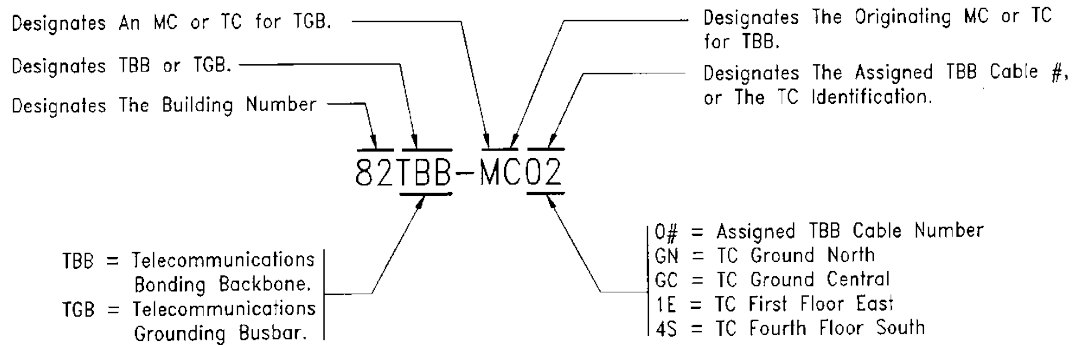
3.6 GROUNDING AND BONDING

A. Telecommunications Main Grounding Busbar (TMGB)

1. Label Location: On the left side of the bus bar on the bus bar wallstandoff.
 2. Label Information: The letters TMGB are unique to the building. The identifier information is identified on the grounding drawings.
 3. Method: A white plastic tag with the printed Brady label affixed to it shall be fastened to the busbar wall standoff with a nylon cable tie facing out for readability.
 4. Tag part number: U.G. Products Co. Inc., white plastic, 2" x 2-1/2", No.100W
 5. Brady label part number: PSL-514-619
 6. Format: All capital letters. The font should be as large as possible to fill the label space with the information. It should be Helvetica or equal and bold, one-line format.
 7. Example: TMGB
- B. Telecommunications Grounding Busbar (TGB)
1. Label Location: On the left side of the bus bar on the bus bar wallstandoff.
 2. Label Information: Refer to the labeling detail at the end of this section. The identifier information is identified on the grounding drawings.
 3. Method: A white plastic tag with the printed Brady label affixed to it shall be fastened to the busbar wall standoff with a nylon cable tie facing out for readability.
 4. Tag part number: U.G. Products Co. Inc., white plastic, 2" x 2-1/2", No.100W
 5. Brady label part number: PSL-514-619
 6. Format: All capital letters. The font should be as large as possible to fill the label holder space with the information. It should be Helvetica or equal and bold, one-line format.
 7. Example: 82TGB-TR1E
- C. Telecommunications Bonding Backbone (TBB)
1. The Telecommunications Bonding Backbone (TBB) bonds the TMGB to the TGB. Multiple TBBs may exist, and the number depends on the methods used to interconnect them.
 2. Label Location: The label shall be placed near the end of the insulation, on the conductor at each end, and at each break in the insulation (for connection to another conductor or a busbar).
 3. Label Information: Refer to the labeling detail at the end of this section. The identifier information is identified on the grounding drawings.
 4. Method: Machine-printed Brady Labels
 5. Brady Label part number: WML-1223-292
 6. Format: All capital letters. The font should be as large as possible to fill the label space with the information. It should be Helvetica or equal and bold, one-line format.
 7. Example: 2TBB-MC02
- D. Interconnecting Bonding Conductor (IC)
1. Referred to in TIA/EIA-607 as the Bonding Conductor for Telecommunications.
 2. The Interconnecting Bonding Conductor bonds the Service Entrance to the TMGB. Typically, there is only one IC.
 3. Label Location: On the conductor at each end. The label shall be placed near the end of the conductor at the connection to the Service Entrance and the TMGB.
 4. Label Information: The letters IC followed by the sequence number (1 numeric character). The sequence number shall be unique to the building. The identifier information is identified on the grounding drawings.
 5. Method: Machine-printed Brady Labels
 6. Brady Label part number: WML-1223-292
 7. Format: All capital letters. The font should be as large as possible to fill the label space with the information. It should be Helvetica or equal and bold, one-line format.
 8. Example: IC1
- E. Equipment Bonding Conductor (EK)
1. The Equipment bonding conductor (EK) bonds the TMGB and TGB to other metallic items, including electronic equipment.
 2. Label Location: On the conductor at each end and at each break in the insulation (for

connection to another conductor or a busbar). The label shall be placed near the end busbar or the break in the insulation, whichever applies.

3. Label Information: The letters EK followed by the sequence number (3 numerical characters). The sequence number shall be unique to the Telecommunications Room and entrance facility. The Contractor shall assign the numbers as necessary to accomplish the installation.
4. Method: Machine-printed Brady Labels
5. Brady Label part number: WML-1223-292
6. Format: All capital letters. The font should be as large as possible to fill the label space with the information. It should be Helvetica or equal and bold, one-line format.
7. Example: EK001



TGB & TBB LABELING DETAIL

3.7 OPERATIONAL SIGNS

- A. Provide instructional signs with approved legends where system or equipment operation instructions or explanations are needed.

END OF SECTION 270553

SECTION 27 11 16
COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1119 – Communications Termination Blocks and Patch Panels
- H. Section 27 1123 – Communications Cable Management and Cable Runway
- I. Section 27 1313 – Communications Copper Backbone Cabling
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.4 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.5 SYSTEM DESCRIPTION

- A. The predominant type of rack to be furnished and installed in support of the Owner's information transport systems shall be as follows:

1. Single Upright, Two-Post Open Frame Universal "Relay Rack" Style

- B. Open-frame equipment racks, 19 inches wide x 84 or 96 inches high, shall be furnished and installed so that rear access is available for installation and maintenance. Racks shall be bolted to the floor. The tops of the racks shall be securely braced to rigid cable runways and bracketed to the wall. All hardware shall be provided for protection within seismic zones, where applicable.
- C. Occasionally, under the specific direction of the Owner, racks may be wall-mounted or floor-supported. Wall/floor racks must be approved in writing in each instance. Refer to the criteria contained herein.
- D. Contractors shall observe the following minimum clearance requirements unless otherwise directed by the Owner or the Architect.
- E. Racks shall be mounted to allow a minimum of 36" access space in both front and rear.
 - 1. The sides of a rack or group of racks situated against a wall shall have a minimum of 6" clearance from the rack to the adjacent wall, with 12" preferred where TR allows. Clearance for the access "walk around" end shall be 24" at minimum and 36" where code clearance is required.
- F. Raised Access Floor Enclosures shall support a flexible zoned cabling distribution system based upon standard modular patch panel mountings.

1.6 QUALITY ASSURANCE

- A. All cables and equipment shall be installed neatly and workmanlike. All methods of construction that are not explicitly described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the manufacturers listed as acceptable. Where "approved equal" is stated, equipment shall be equivalent to the specified equipment and subject to approval.
- B. When installing communications/data cabling, strictly adhere to all recommended installation practices by Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA), and Telecommunications Industry Association (TIA).

1.7 SUBMITTALS

- A. Refer to Section 270000 – Communications General
- B. Product Data Sheets
- C. Bill of Materials

1.8 MATERIALS FOR USE BY OWNER

- A. Furnish materials to the Owner as described below:
 - 1. All rack screws over those required to install panels and devices shown in Project Drawings. Refer to Part 2 Products.
 - 2. All panels over those required to install panels and devices shown in Project Drawings. Refer to Part 2 Products.
- B. Materials shall be securely stored at the project site throughout the installation. When called for

by the Owner, the Contractor shall deliver the materials, obtaining a signature of acceptance and delivery from the Owner.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden
- B. CPI (Chatsworth Products Incorporated)
- C. Panduit Corporation

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 OPEN FRAME EQUIPMENT RACKS – SINGLE UPRIGHT, 2-POST

- A. Racks shall be manufactured from 16GA steel base and 12GA steel uprights.
- B. Equipment mounting channels shall be 3" deep and punched on the front flange with the EIA-310-D universal hole pattern to provide forty-five (45) rack-mount spaces for equipment in an 84" high frame and fifty-two (52) rack-mount spaces for equipment in a 96" high frame.
- C. Equipment-mounting channels shall be spaced to allow 19" EIA rack-mount equipment to be attached. Attachment points shall be tapped with 10-32 holes. The rack shall include assembly and equipment, such as mounting hardware. Each rack shall consist of fifty (50) each combination pan heads, and pilot point mounting screws.
- D. The assembled rack shall measure 7' (84") or 8' (96") high x 19" wide. The sides (webs) of the equipment-mounting channels shall be punched to allow vertical cable managers to attach along the sides of the rack or for rack-to-rack baying.
- E. Racks shall be rated for 500 lb. of equipment.
- F. Finish shall be black.
- G. Furnish and install all necessary hardware for mounting equipment racks. Racks shall be securely mounted at both the top and bottom. If this is not possible, the Owner shall be notified immediately.
- H. Furnish and install all necessary hardware for mounting, grounding, and bonding equipment in equipment racks as per the Panduit Structured Ground™ System. Refer to Section 270500– Common Work Results for Communications.

2.4 RAISED FLOOR ENCLOSURES

- A. Enclosure shall require the removal of only one-floor tile and drop through a single tile opening without disassembly to install. Mounting brackets shall be a one-piece design without any loose hardware for easy attachment to raised floor pedestals.
- B. When installed, the enclosure shall be properly grounded and bonded to the raised floor system without the need for additional jumpers or other components.
- C. Enclosure shall meet UL2043 requirements for use in a plenum space, be available in multiple sizes, and be configurable for both field-terminated and pre-terminated connectivity.
- D. The enclosure and cable openings shall be able to support forty-eight (48) Category 6 cables per rack space.
- E. The enclosure shall have flexible cable ingress/egress grommets that allow for quick and easy moves, additions, and changes while still maintaining a plenum rating.
- F. Enclosure shall be capable of being secured and protected from unauthorized access with a lockable cover.

PART 3 – EXECUTION

3.1 GENERAL

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other components for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.

3.2 EQUIPMENT INSTALLATION

- A. Open Frame Equipment Racks – Single Upright, 2-Post
 - 1. Assemble racks according to the manufacturer's instructions. Before attaching the rack to the floor, verify that the equipment mounting rails are sized properly for rack-mount equipment.
 - 2. All racks shall be attached to the floor in four places using appropriate floor mounting anchors. When placed over a raised floor, threaded rods should pass through the raised floor tile and be secured in the structural floor below. (Use CPI #40604-003 for concrete slab floors or #40607-001 for wood floors. Raised floor support kits are also available.)
 - 3. All Racks shall be individually (home-run) grounded to the TGB using appropriate hardware provided by the Electrical Contractor. The ground shall meet local code requirements and be approved by the Authority Having Jurisdiction (AHJ). Refer to Section 270500 – Common Work Results for Communications.
 - 4. Racks shall have additional bracing as required by building codes and the recommendations of a licensed Structural Engineer for seismic.
 - 5. A Cable Runway shall be attached to the top of the rack to deliver cables to the rack. The rack should not be drilled to attach the Cable Runway. Use appropriate hardware from the Cable Runway manufacturer. Refer to Section 27 11 23 – Communications Cable Management & Cable Runway.
 - 6. Communications Cable Management shall be attached to the sides of the rack to deliver cables to it. The rack should not be drilled to attach cable management. Use appropriate hardware from the cable management manufacturer. Refer to Section 271123– Communications Cable Management & Cable Runway.
 - 7. The equipment load should be evenly distributed and uniformly on the rack. Place large and heavy equipment towards the bottom of the rack. Secure all equipment to the rack with

equipment mounting screws.

B. Raised Floor Enclosures

1. Assemble enclosures according to manufacturer's instructions.
2. Locations shall be selected to ensure no obstacles interfere with the installation.
3. Four (4) support brackets shall be mounted under the enclosure, one on each pedestal mount bracket, and the U-bolt and nut attached around the pedestal. Refer to manufacturer instructions for adjustment to various pedestal sizes. Use a magnetic ruler to measure the correct mounting location for each support bracket. The brackets must be mounted so that the gasket will form a seal with the floor tile.
4. Install four (4) Cool Boot assemblies inside the enclosure and then insert the enclosure in the desired floor tile.
5. Install pedestal mount bracket assemblies according to manufacturer instructions. Enclosure shall be mounted to the pedestal mounting brackets using the supplied 1/4" x 20 bonding bolts.

END OF SECTION 271116

SECTION 27 11 19
COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1123 – Communications Cable Management and Cable Runway
- I. Section 27 1313 – Communications Copper Backbone Cabling
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 270000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SUMMARY

- A. This Section includes:
 - 1. Panels for Backbone Cabling Systems
 - 2. Panels for Horizontal Cabling Systems
 - 3. Termination Blocks for Voice BDF (Building Distribution Frames)

1.4 DEFINITIONS

- A. Refer to Section 270000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 270000 – Communications General

1.6 SUBMITTALS

- A. Refer to Section 270000 – Communications General Product Data Sheets
- B. Specification Sheets for Test Equipment Bill of Materials
- C. Contracting Firm Qualifications and Certifications Installation Team Qualifications by Individual
- D. Current Manufacturer Certifications

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 -Products
- B. Bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 DISTRIBUTION PANELS FOR OPTICAL FIBER BACKBONE CABLING

- A. Optical Fiber Distribution Panels shall be rack mount enclosures with front and rear removable doors, removable top, and Front and Rear removable cassettes. Maximum frame capacity: 1U = 32 LC Duplex; 2U = 96 LC Duplex; 4U = 192 LC Duplex.
- B. Each panel shall include a full complement of blank adapter panels, labels, cable storage accessories, and optical fiber cable routing accessory kit.
- C. Optical Fiber Distribution Panels shall include “LC” style coupler panels and connectors as required for the complement of multimode optical fiber elements and “ST” style coupler panels and connectors as required for the complement of single-mode optical fiber elements, as indicated on the Project Drawings.
- D. Multimode Connector Panels shall be color-coded according to the optical fiber type for which they are applied. Laser-optimized OM4 50/125µm multimode shall be aqua.
- E. Single-mode Connector Panels shall be color-coded according to the optical fiber type to which they are applied. 8.3/125µm single mode shall be blue.

2.4 PATCH PANELS FOR COPPER HORIZONTAL CABLING

- A. MC, TR, and other information transport distribution spaces:
 - 1. Provide High Density 24- and 48-Port Category 6a UTP Patch Panels with insulation piercing connecting blocks for termination of all horizontal channels. Insulation piercing connecting blocks shall be based on linear REVConnect style technology.
 - 2. Patch Panels shall contain 8-position RJ-45 UTP ports that meet or exceed transmission performance of Category 6a for the horizontal channel.
 - 3. Patch Panels shall terminate four (4) pairs of Category 6a UTP horizontal cabling per jack.
- B. All ports installed for Category 6a UTP shall be black.

2.5 TERMINATION BLOCKS FOR COPPER BACKBONE/RISER CABLING

- A. Termination blocks shall be REVConnect Wall-Mount Termination Kit Coupler style, 96 Port. Includes wall mount frame, six termination blocks, and 100 REVConnect cores.
- B. Blocks shall meet Category 6a specifications as verified by an independent testing laboratory, at minimum, and shall support the termination of 22-24AWG solid conductors.
- C. Patch cord slack must be eliminated with cut-to-length management.
- D. Termination blocks shall be used at the voice backbone cabling origination point within the MC and TR, as shown in the Project Drawings.
- E. Furnish and install wall-mounted backboard channels and troughs.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. All Patch Panels, Distribution Panels, and Blocks shall be securely mounted in the rack or on the wall with a minimum of four (4) rack screws located in the four corners of each panel/block.
- B. All Panels shall be arranged in sequential order from top to bottom and left to right within racks and shall be labeled in alphanumeric order according to the Owner-approved labeling scheme.
- C. Panels for shielded cabling, where applicable, shall be bonded and grounded to rack frames within which they are installed and terminated directly to the TGB (Telecommunications Grounding Busbar) within each TR space.

3.2 WIRE AND CABLE IDENTIFICATION

- A. Furnish and install labels as identified in Specification Section 270553 Identification for Communication Systems.

END OF SECTION 27 11 19

SECTION 27 11 23
COMMUNICATIONS CABLE MANAGEMENT AND CABLE RUNWAY

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1313 – Communications Copper Backbone Cabling
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.4 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.5 SYSTEM DESCRIPTION

- A. Vertical Cable Management sections, 84" H, shall be bolted between all Open Frame Racks. The width of Vertical Cable Management sections shall be as indicated on the Project Drawings.

- B. Horizontal Cable Managers shall be bolted between Patch Panels. Location of Horizontal Managers shall be as indicated on Project Drawings
- C. The work covered under this section consists of furnishing all necessary coordination, labor, supervision, materials, equipment, tests, and services required to install complete Cable Runway systems within all EF, MC, TR, and ICC spaces, as indicated within Project Drawings.

1.6 QUALITY ASSURANCE

- A. All cables and equipment shall be installed neatly and workmanlike. All methods of construction that are not explicitly described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the manufacturers listed as acceptable. Where "approved equal" is stated, equipment shall be equivalent in every way to the equipment selected and subject to approval.
- B. When installing communications/data cabling, strictly adhere to all recommended installation practices by Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA), and Telecommunications Industry Association (TIA).

1.7 SUBMITTALS

- A. Refer to Section 270000 – Communications General
- B. Product Data Sheets
- C. Bill of Materials

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden
- B. CPI (Chatsworth Products, Inc.)

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 -Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 CABLE MANAGEMENT

- A. Vertical Cable Management for Racks/Frames
 - 1. Every Rack/Frame shall have at least one Vertical Cable Manager furnished and installed between racks and at the end of multiple rack line-ups. The Vertical Cable Manager shall create a space for storing and organizing cables along the side of each Rack/Frame.

2. Vertical Cable Manager width shall be sized as indicated on Project Drawings.
3. The Vertical Cable Manager shall match the height of the Rack/Frame to which it is attached.
4. Vertical Cable Manager shall bolt to the side of Racks/Frames using factory-provided hardware and mounting provisions. The Vertical Cable Manager shall be the same manufacturer as the Racks/Frames. Refer to Section 17 11 16 – Communications Cabinets, Racks, Frames, & Enclosures.
5. The Vertical Cable Manager shall be a double-sided H-shaped trough. The front and rear metal edges between the latches shall be covered by plastic edge protectors to protect cables. The double-sided trough shall provide independent front and rear cable pathways and multiple evenly-spaced edge-protected front-to-rear cable pass-through holes for cables in the center divider.
6. Reference: Section 270000 Communications General, Part 2 –Products.

B. Horizontal Cable Management for Racks/Frames

1. Furnish and install Horizontal Cable Managers 19" W x 3" H (2RU) where expressly indicated on Project Drawings.
2. The manager shall be black.

2.4 CABLE RUNWAY AND ACCESSORIES

- A. Cable Runway shall be manufactured from 3/8" wide by 1-1/2" high tubular steel with .065" wall thickness.
- B. Cable Runway (side stringers) shall be 9'-11½" long. Cross members shall be welded in between stringers on 12" centers beginning 5-3/4" from one end so that there are ten cross members per Cable Runway. There shall be 10-1/2" of open space in between each cross member.
- C. The finish shall be a black epoxy-polyester hybrid powder coat (paint).
- D. Furnish and install 6-inch, 12-inch, and 18-inch ladder-style cable runway sections in each TR and information transport systems space, as indicated on the Project Drawings. The Cable Runway shall be securely mounted to the top of equipment racks using all necessary hardware.
- E. Cable Runway shall be black. Include J-Bolts and associated mounting hardware.
- F. Cable Runway Radius Drops shall be mounted to stringer and cross members using clevis pins, where cabling must turn down into the tops of vertical cable managers. The drops shall be black.
- G. Channel Mounting Plates shall be 3" and black. They shall include associated mounting hardware.
- H. Wall Mounting Angles shall be black. Include J-Bolts and associated mounting hardware.
- I. Vertical Wall Brackets.
- J. Cable Runway Foot.
- K. Butt Splice Kits.

- L. Triangular Support Brackets shall be black.
- M. Runway/Enclosure Junction Kits shall be black.
- N. Cable Runway Elevation Kit shall be used to transition between racks of unequal heights. Kits shall be black.
- O. Cable Retaining Posts shall be installed to create a cable trough effect using a ladder-style tray. The posts shall be black.
- P. Cable Runway Pathway Dividers shall be installed to route backbone cabling away from horizontal cabling bundles separately, where entering the TR are routed to destination racks(s).
- Q. Protective End Caps shall be black.
- R. Furnish and install all hardware required to form a complete system, whether or not specifically listed herein. Examples of required miscellaneous hardware include, but are not limited to, threaded rods, threaded rod covers, beam clamps, lock nuts, runway and ceiling support brackets, slip-on support brackets, vertical wall brackets, etc.

PART 3 – EXECUTION

3.1 GENERAL

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.

3.2 EQUIPMENT INSTALLATION

A. VERTICAL CABLE MANAGEMENT

- 1. Vertical Cable Managers shall be attached to the side of the Rack/Frame using the manufacturer's installation instructions and included hardware. No holes shall be drilled in the racks/frames to install mismatched managers.
- 2. When a single Vertical Cable Manager is used between two Racks/Frames, attach it to both Racks/Frames.
- 3. When more than one (1) Vertical Cable Manager is used on a Rack/Frame or group of Racks/Frames, use the same make, style, and size of Vertical Cable Manager on the Rack/Frame or in between Racks/Frames.
- 4. The color of the Racks/Frames and Vertical Cable Managers shall match.

B. HORIZONTAL CABLE MANAGEMENT

- 1. All Managers shall be securely mounted in the rack with a minimum of four (4) rack screws located in the four corners of each panel.

C. CABLE RUNWAY

1. Cable Runway shall be installed with side stringers facing down so that the ladder forms an inverted U-shape and so that welds between the stringers (sides) and cross members (middle) face away from cables.
2. The Cable Runway shall be supported every 5 feet in the center with a 5/8-inch diameter threaded rod or applicable support brackets or racks. The exposed portion of the threaded rod shall be protected with a tubular cover throughout the portion of the rod exposed to cabling within the maximum fill area.
3. Cable Runway shall be secured to the structural ceiling, building truss system, wall, floor, or the tops of equipment racks and cabinets using the manufacturer's recommended supports and appropriate installation hardware and methods as defined by local code or the authority having jurisdiction (AHJ).
4. Cable Runway splices shall be made in mid-span, not over support, using the manufacturer's recommended splice hardware.
5. Cable Runway shall be supported every 5' or less per TIA-569-B. The Cable Runway shall be supported within 2' of every splice and 2' on both/all sides of every intersection. Support Cable Runway within 2' on both sides of every elevation change. Support Cable Runway every 2' when attached vertically to a wall.
6. Heavy-duty splices are recommended for cable runways over 18" in width (18" wide cable runway). Heavy-duty splices are required for any splice formed in the vertical orientation, including elevation changes formed using vertical-to-horizontal 90° turns or horizontal-to-vertical 90° turns. Use heavy-duty splices to secure all overhead turns to the overhead horizontal pathway(s).
7. When the pathway is overhead, the Cable Runway shall be installed with a minimum clearance of 12" above the Cable Runway. Leave a minimum of 12" in between the Cable Runway and the ceiling/building truss structure. Leave a minimum of 3" between the Cable Runway and the tops of equipment racks and cabinets. Multiple tiers of the Cable Runway shall be installed with a minimum clearance of 12" between each tier of the Cable Runway. When located above an acoustical drop ceiling, leave a minimum of 3" clearance between the top of the drop ceiling tiles and the bottom of the Cable Runway.
8. When installed under a raised floor, Cable Runway shall be installed with a minimum 3" clearance between the top of the Cable Runway and the bottom of the floor tiles or floor system stringers, whichever is lower in elevation. Maintain a 3" clearance between Cable Runways wherever Cable Runways cross.
9. Within each TR, the Cable Runway should be bonded together, electrically continuous, and bonded to the TMGB and TGB unless otherwise specifically noted in the Project Drawings. Cable Runway and turns shall be bonded with a bonding kit across each splice. The Cable Runway shall be bonded to the TMGB and TGB using an approved ground lug on the Cable Runway and a minimum #6 grounding wire or as the AHJ recommends. Remove paint from the Cable Runway where bonding/ground lugs contact the Cable Runway so that the lug shall contact bare metal. Use antioxidant joint compound between the bare metal on the Cable Runway and the ground lug. Use an antioxidant joint compound between the bus bar and the ground lug. Verify continuity through the bonds at splices and intersections between individual Cable Runway sections and turns and through the bond to the TMGB and TGB.
10. The combined weight of cables within the Cable Runway shall not exceed the stated load capacity of the Cable Runway as stated in the manufacturer's product specifications or load/design tables.

11. Straps shall not be required when the Cable Runway has cable retaining posts.
12. Add 8" high cable retaining posts to the open sides of the Cable Runway as indicated in Project Drawings. Cable fill within any Cable Runway should not exceed 6" in height.
13. When a single Cable Runway supports different cable media types, the cable media shall be separated within the pathway by cable spools that attach to the cross members on the Cable Runway.
14. Use a radius drop to guide cables wherever they exit an overhead Cable Runway to access a rack, cabinet, or wall-mounted rack, cabinet, or termination field. Furnish and install a moveable cross member to attach and align the radius drop between the welded cross members of a Cable Runway.
15. Cover the exposed ends of the cable runway that do not terminate against a wall, the floor, or the ceiling with end caps or an end-closing kit.
16. Use auxiliary support brackets that attach to the side stringer of the Cable Runway to support interconnect cabling (patch cords, equipment cords, jumper cords) routed between racks using the Cable Runway. Auxiliary support brackets can also be used to support other conductors that should be physically separated from cables within the Cable Runway as defined by local code or the authority having jurisdiction (AHJ).
17. Whenever possible, maintain a 2' separation between Cable runways used for communications cables and pathways for other utilities or building services.
18. The installer shall furnish and apply color-matched touch-up paint to the Cable Runway finish. It shall correct any minor cosmetic damage (such as chips and small scratches) resulting from ordinary handling during the installation process before delivery to the Owner. Suppose a component is cosmetically damaged to the extent that correction in the field is evident against the factory finish. In that case, the component shall be replaced with a new component finished by the factory. If an element is physically damaged due to mishandling or modification during installation, it shall not be used as part of the Cable Runway system.
19. Install Cable Runway level and straight unless noted explicitly on Project Drawings.
20. Furnish and install seismic protection products for all Cable Runway hardware assemblies.
21. Alternate spacing ladder arrangements shall be made for all Cable Runway runs above and parallel to TR rack rows so that space above the entry point into vertical wire managers remains clear, and precise alignment of cable runway radius drops can be assured.
22. A ladder-type runway shall carry a uniformly distributed load of 135 lbs./ft. on a five-foot support span with a safety factor of 1.5 when supported as a simple span. The load and safety factors specified apply to both side rails and rung capacities.

END OF SECTION 27 11 23

SECTION 27 11 26
COMMUNICATIONS POWER PROTECTION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Installation of OFCI rack-mounted Power Distribution Units and **Uninterruptible** Power Supply (UPS) systems, and related hardware for battery backup for the specified runtime, and temperature probe monitoring and communications capabilities.

1.2 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. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1119 – Communications Termination Blocks and Patch Panels
- H. Section 27 1123 – Communications Cable Management and Cable Runway
- I. Section 27 1313 – Communications Copper Backbone Cabling
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.3 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.4 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

- B. OFCI – Owner Furnished, Contractor Installed
- C. PDU – Power Distribution Unit
- D. UPS – Uninterruptible Power Supply

1.6 SYSTEM DESCRIPTION

- A. Install line-interactive UPS systems in the following rooms:
 - 1. 119 MDF/IDF
 - a. (2) PDU
 - b. (2) UPS + (2) Network Management Cards
 - c. (2) Battery Expansion
 - d. (1) Temp Humidity Probe
- B. UPS shall provide conditioned power to connected equipment, protecting against voltage sags, surges, and blackouts.
- C. UPS shall be rack-mounted in standard 19-inch equipment racks.
- D. Include all necessary hardware and software for installation, operation, and monitoring.

1.6 QUALITY ASSURANCE

- A. All cables and equipment shall be installed neatly and workmanlike. All methods of construction that are not explicitly described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated.
- B. When installing communications/data cabling, strictly adhere to all recommended installation practices by Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA), and Telecommunications Industry Association (TIA).

1.7 SUBMITTALS

- A. Refer to Section 270000 – Communications General

PART 2 – PRODUCTS

2.1 Install and test the following Equipment:

- A. 119 Telecom
 - 1. (2) CyberPower CP1500AVRLCD3
 - 2. (2) Network Management Card
 - 3. (1) Temp Humidity Probe

PART 3 – EXECUTION

3.1 GENERAL

- A. Verify that the site conditions are acceptable for the installation of the UPS system.

- B. Verify that the electrical service is of the correct voltage and phase.
- C. Verify that the equipment rack is suitable for the weight and dimensions of the UPS system.

3.2 INSTALLATION

- A. Install the UPS system in accordance with the manufacturer's instructions.
- B. Mount the UPS securely in the equipment rack.
- C. Connect the UPS to the electrical service in accordance with the NEC and local codes.
- D. Connect the communications equipment to the UPS output receptacles.
- E. Install optional network management card, if specified.
- F. Install any external battery packs, if specified, according to the manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

- A. Perform startup testing per the manufacturer's recommendations.
- B. Test the UPS system under simulated power failure conditions to verify proper operation of the batteries and transfer circuitry.
- C. Verify that the UPS provides the specified runtime.
- D. Test communications and monitoring functions.

3.4 ADJUSTING

- A. Adjust UPS settings as required to meet project requirements.
- B. Configure alarms and notifications.

3.5 CLEANING

- A. Clean up installation debris and remove from site.

3.6 DEMONSTRATION

- A. Demonstrate proper operation of the UPS system to the Owner's representative.
- B. Provide training to the Owner's personnel on the operation and maintenance of the UPS system.

END OF SECTION 27 1116

SECTION 27 13 13
COMMUNICATIONS COPPER BACKBONE CABLING

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1123 – Communications Cable Management and Cable Runway
- J. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SYSTEM DESCRIPTION

- A. The copper backbone hierarchy employed by the Owner includes Interbuilding, Intrabuilding, and Service Provider cabling systems.
- B. Interbuilding copper cabling systems, where applied, represent the primary copper riser/distribution system originating at the PBX Room or voice services “hub” serving the Owner’s campus. The end destination of each interbuilding backbone link is a termination point within the EF (Entrance Facility).
- C. Intrabuilding copper cabling systems represent the primary copper riser/distribution system,

originating within the EF and MC (Main Cross-Connect), that serve TR (Telecommunications Room) or ICC (Intermediate Cross-Connect) facilities located on the same floors and those above or below. Each floor shall have at least one (1) TR, and larger buildings shall have more than one (1). Intrabuilding cabling systems may also contain optical fiber identified as part of the horizontal cabling.

- D. Service Provider cabling systems are not-in-contract but require pathways furnished and installed by Division 26.
- E. Refer to Project Drawings, "Technology Building Riser," for specific requirements of each building site.

1.4 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.6 SUBMITTALS

- A. Refer to Section 27 0000 – Communications General - Product Data Sheets
- B. Specification Sheets for Test Equipment
- C. Bill of Materials
- D. Contracting Firm Qualifications and Certifications
- E. Installation Team Qualifications by Individual
- F. Current Manufacturer Certifications

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 27 0000 Communications General, Part 2 -Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not specifically identified, itemized, and quantified.

2.3 COPPER BACKBONE CABLING –INTRABUILDING

- A. Multi-pair copper backbone cables from the MC shall be home-run routed directly to the TR(s).

- B. ISP Copper Backbone Cable shall be Category 5e rated, multi-pair 24 AWG riser, or plenum-rated as required. It shall consist of solid copper conductors tested to meet Category 5e performance. The cable shall be UL[®] tested and listed as CMR or CMP as required for the environment into which it will be placed. The cable shall be available in 25-pair increments.
 - C. Where pair capacity is not specified in Project Drawings, multi-pair cabling shall be sized to provide two (2) pairs per 4-pair TO (Telecommunications Outlet) to be installed with a minimum pair count of 25.
 - D. Cables shall be gray.
- 2.4 COPPER BACKBONE CABLING – INTERBUILDING (OSP)
- A. Shall be Owner Furnished and Installed.
- 2.5 COPPER BACKBONE SPLICING - INTERBUILDING ONLY (OSP)
- A. Shall be Owner Furnished and Installed.

PART 3 – EXECUTION

3.1 FIELD CONDITIONS

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other components for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.
- B. Unless otherwise noted, the footage for cabling and materials shown on the Project Drawings are based upon available plant records, Architectural drawings, or the Architect's route and pathway assumptions. The Contractor shall be required to perform field surveys and measurements before ordering materials.
- C. Unless otherwise stated, the more restrictive shall be applied where installation requirements identified in Reference Standards conflict with the manufacturer's recommendations.
- D. Bring to the attention of the Owner and Architect conflicts between the manufacturer's instructions and Contract Documents.

3.2 COPPER CABLE INSTALLATION

- A. The Contractor shall field survey and review with the Owner and Architect similar installations on campus that contain the same type of materials used for this Project to achieve the desired routing and layout, installation techniques, and finished look prior to the start of construction and as often as necessary during the construction process.
- B. Install all cables through primary and secondary pathways. Unless otherwise specified, installation methods and techniques shall satisfy ANSI/EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. Where cables are supported from the building structure, they shall be adequately supported such that the cable will not be damaged by normal building use.

- D. Cables shall not be installed or routed in any manner that violates the manufacturer's specifications. The manufacturer's minimum bend radius for static (post-installation) cables is ten times the cable diameter. The manufacturer's minimum bend radius for cables under strain (pulling tension) is 20 times the cable diameter.
- E. Unless otherwise specified, terminate cables per ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, observing the industry standards for terminating color-coded cables for premises and campus environments.
- F. Do not install damaged or defective cables. Installation of damaged cable will not be accepted. Unless otherwise allowed by the Owner, damaged cable shall be removed and new cable installed at the Contractor's expense. Damage includes physical damage to the cable and damage that may affect performance. The Owner will not accept cable of any type until it is installed and passes a physical inspection and all performance tests.
- G. Cable Support along Primary Pathway
1. Primary pathways include major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas, which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.
 2. Where the cable tray cannot be installed to be continuous, provide support and strain relief for cables using mechanical fasteners such as J-hooks, conduit, C-channel, and other necessary devices to support cables around discontinuity. In exposed areas, support cables as indicated on the Drawings.
 3. Where a telecommunication raceway, cable tray, or cable rack is provided, all telecommunication cables shall utilize the system except:
 - a. Emergency System Wiring
 - b. Fire Alarm Systems
 4. Cables shall be routed to avoid cable crossover between cable continuing vertically floor-to-floor and cable routed horizontally.
 5. Cable installation and cable routes shall be planned and cables shall be installed such that the capacity of the conduit, sleeves, and cable tray is used most efficiently.
 6. Bundle and route cables throughout the building to maintain neat, uniform, and combed bundles. Where cable is exposed in vertical runs, such as utility shafts, provide reusable cable straps to neatly contain cable bundles.
 7. Use common vertical sleeve(s) for routing of all copper intra-building backbone/riser cables. Provide strain relief for cables routed vertically using mechanical fasteners such as conduit, C-channel, reusable cable straps, other necessary devices (such as Erico/Caddy #CAT600WM) to support cables.
 8. Secure all intra-building backbone cables to the MC and TR walls to prevent movement of the cable. D-rings shall be acceptable for this purpose.
 9. Secure the cables to the Cable Runway to prevent movement of the cable and use the horizontal Cable Runway to route the cable to the point of termination.
 10. Staples may NEVER be used to secure cables.
 11. Furnish a fifteen (15) foot service loop within all MC and TR locations.
 12. All cabling shall be continuous and without splices, except to attach to BETs.
- H. Cable Support Along Secondary Pathway
1. Secondary pathways extend from the primary pathway to the communication outlet box and carry cable from the primary pathway to the communication outlet box.
 2. Cable shall be routed parallel and perpendicular to walls and floor from the primary pathway to the outlet box. Where multiple routes are possible, route cable along the shortest path to minimize cable length as practicable.
 3. Attaching or otherwise draping cables to ceiling wire grids, pipes by other trades, lighting fixtures, etc., shall not be permitted.
 - a. Do not use suspended ceiling support hangers (wires) to support station cables.

- b. Do not support cables from other mechanical, electrical, or plumbing systems.
- c. Staples may NEVER be used to attach or support cables.
- d. Station cables shall be supported so they do not rest on the suspended ceiling system.
- 4. The building structure shall support cables and cable pathways. A superstructure designed and intended to support multiple utilities may be used for communications cables if the structure can physically support the additional load and if the support mechanism for the cable works for supporting the cable.
- 5. J-Hooks and other independent cable supports shall be located on 48" to 60" centers to support and distribute the cable weight adequately.
- 6. The Contractor shall determine the route and quantity of J-Hooks and other independent cable supports within the overhead ceiling space wherein cable tray or other support systems have not been provided by Division 26.
- 7. Where J-Hooks and independent cable supports are used, runs shall follow walls and building supporting structures; diagonal runs are unacceptable.
- 8. Place cables without exceeding the cable manufacturer's recommended pulling tensions.
- 9. Pull cables simultaneously if more than one is pulled in the same raceway.
- 10. Use pulling compound or lubricant only if necessary. Use compounds that will not damage the conductor or insulation.
- 11. Use pulling means, including fish tape, cable, rope, and basket weave or cable grips, that will not damage cabling or raceways.

3.3 CROSS-CONNECT JUMPERS

- A. Coordinate installation of jumpers with the Owner before starting work.
- B. Provide a 2" minimum and 4" maximum service loop in each cross-connect jumper for voice and data circuits at each end.
- C. Cross-connect jumpers shall be uniform in shape.
- D. Plan and route cross-connect jumpers for voice and data circuits through the jumper ring on the frames so they are not intermixed haphazardly. Keep voice and data cross-connect jumpers as segregated as possible.

3.4 CABLE MANAGEMENT AND ROUTING AT DISTRIBUTION FRAMES

- A. Cabling shall be arranged by cable number on the patch panels in sequential numerical order.
- B. Cabling shall be arranged on the termination blocks in sequential numerical order by cable pair.
- C. At distribution frames, route cables along the backboard vertically and horizontally to avoid diagonal routing. Where the termination location is unspecified, neatly coil enough cable slack in each closet to reach the farthest corner of the backboard, routing vertically and horizontally.
- D. Plan cable layout, routing, and cable management on the backboard such that:
 - 1. Cable cross-over is minimal.
 - 2. Cables are kept as short as practicable.
 - 3. Station and equipment cables are neatly shaped, combed, and bundled vertically and horizontally.

3.5 COPPER CABLE SPLICES

- A. Splices in backbone cables shall be made using mechanical tools, modules, and connectors of the same manufacturer, specifically designed for the type and size of cable being spliced.
- B. All splices shall be performed in a splice closure specifically designed for the number of cables, size of cables, quantity of conductors, and environment of the splice.
- C. Metallic shields of telecommunications cables shall be bonded within the closure of all splices.
- D. All cables entering a splice case shall be supported independent of the splice case to a supporting structure so that the splice case is accessible for re-entry.
- E. Splicing of cables containing energized circuits shall be coordinated with the Owner

3.6 CABLE REMOVAL

- A. All copper riser cable and termination hardware that is replaced with new shall be removed.
- B. The existing twisted pair communications cable and hardware in the project area that was abandoned prior to this Project shall be removed.
- C. Conduit and enclosures shall remain. Blank covers shall be provided for abandoned junction boxes.
- D. After the cable is removed, the affected penetrations and sleeves shall be fire-stopped to maintain the required fire rating.
- E. Existing termination hardware within the existing telecommunications spaces and communications enclosures shall be removed from service after cutover.
- F. Existing distribution frame hardware and cabling shall be removed after active services are transferred to the new cabling system, as verified at the frame.

3.7 FIRE-STOPPING

- A. Fire-stopping shall be installed after all cabling under contract has been installed. Refer to Specification Section 270500 Common Work Results for Communications

3.8 UTP TESTING AND DOCUMENTATION PROCEDURES

- A. New cable pairs shall be end-to-end tested as follows.
 - 1. DC loop resistance
 - 2. Wire map
 - 3. Continuity to the remote end
 - 4. Shorts between two or more conductors
 - 5. Crossed pairs
 - 6. Reversed pairs
 - 7. Split pairs
- B. Testers may require a BIX-style adapter at the TR location.
- C. All balanced twisted-pair field testers shall be factory-calibrated each calendar year by the field test equipment manufacturer as stipulated in the manuals provided with the field test unit. The calibration certificate shall be provided for review before the start of testing. Auto-test settings, provided in the field tester for testing the installed cabling, shall be set to the manufacturer's default parameters for the type and characteristics of the cable to be tested.

- D. Tests shall be performed with connectors and terminations in place.
- E. Any cable or component not satisfactorily passing the tests described or failing to meet quality installation standards described in this specification shall be repaired and replaced at the Contractor's expense.
- F. The Contractor shall prepare complete cable test reports for all installed cables for the Owner to review and approve before the cabling system's acceptance.

3.9 WIRE AND CABLE IDENTIFICATION

- A. Furnish and install labels as identified in Specification Section 270553 Identification for Communication Systems.

END OF SECTION 27 13 13

SECTION 27 13 23
COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1123 – Communications Cable Management and Cable Runway
- J. Section 27 1313 – Communications Copper Backbone Cabling
- K. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.4 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.5 SYSTEM DESCRIPTION

- A. The optical fiber hierarchy employed by the Owner includes Interbuilding, Intrabuilding, and Service Provider cabling systems, which are designed based on a “hierarchical star” configuration.

- B. Interbuilding cabling systems provide the primary backbone link originating at primary data center facilities on the Owner's Campus. The end destination of each interbuilding backbone link is a termination point within at least one (1) EF (Entrance Facility). Interbuilding cabling is not in the contract and will be provided by the Owner.
 - C. Intrabuilding cabling systems are most often primary backbone links, originating within the EF (Entrance Facility) and MC (Main Cross-Connect), that serve TR (Telecommunications Room) or ICC (Intermediate Cross-Connect) facilities located on the same floors and those above or below. Each floor shall have at least one (1) TR, and larger buildings shall have more than one (1). Intrabuilding cabling systems may also contain optical fiber identified as part of the horizontal cabling.
 - D. Service Provider cabling systems are not in contract but will require pathways that are furnished and installed by Division 26.
 - E. Refer to Project Drawings, "Technology Building Riser," for specific requirements of each building site.
- 1.6 SUBMITTALS
- A. Refer to Section 270000 – Communications General
 - B. Product Data Sheets
 - C. Specification Sheets for Test Equipment
 - D. Bill of Materials
 - E. Contracting Firm Qualifications and Certifications
 - F. Installation Team Qualifications by Individual
 - G. Current Manufacturer Certifications
 - H. 100% Test Results as detailed within PART 3 EXECUTION

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Corning
- B. Belden
- C. Pyramid

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and

functional system, whether or not explicitly identified, itemized, and quantified.

2.3 OPTICAL FIBER BACKBONE CABLING

- A. New segments of multi-element optical fiber backbone cable shall meet the requirements of the National Electrical Code® (NEC)® Section 770. The cable shall be listed as Optical Fiber Nonconductive Riser (OFNR) or Optical Fiber Conductive Riser (OFCR) for riser (non-plenum) applications or Optical Fiber Non-Conductive Plenum (OFNP) or Optical Fiber Conductive Plenum (OFCP) for plenum applications, as required. The indoor backbone fiber shall be multi-mode and single-mode, utilizing a tight buffered, air-core design with all-dielectric strength member construction.
- B. Orange innerduct shall be required with all optical fiber cabling, indoor and outdoor. All conduits designated to contain interbuilding and outside plant (OSP) optical fiber shall also be filled with spare innerducts comprising the total capacity of that conduit. For example, a 4" OSP conduit shall contain a minimum of (3) 1" innerducts if the cabling installation requires using the conduit. Unused conduits shall be left vacant except for pull strings or mule tape.
- C. Minimum bend radius shall be no less than fifteen (15) times outside diameter under full tensile load and no less than ten (10) times outside diameter under no load.
- D. New Multi-mode Optical Fiber segments shall meet the requirements of EIA/TIA-492AAAC "Detail Specification for 850-nm Laser-Optimized, 50µm Core Diameter/125µm Cladding Diameter Class 1a Graded-index Multimode Optical Fibers."
- E. New Single Mode Optical Fiber segments shall meet the requirements of EIA/TIA-492CAAB "Detail Specification for Class 1va Dispersion-un-shifted Single Mode Optical Fibers with Low Water Peak" and ITU recommendation G.652.C, "Characteristics of a Single Mode Optical Fiber Cable."
- F. Color Coding
 - 1. For indoor applications, the color of the outer jacket shall be aqua for cables containing 50/125 µm OM3 Laser Optimized Fiber.
 - 2. For indoor applications, the outer jacket color shall be Erika Violet for cables containing 50/125 µm OM4 Laser Optimized Fiber.
 - 3. For indoor applications, the outer jacket of cables containing single-mode fiber shall be yellow.
 - 4. The jacket shall contain carbon black for outside plant applications to provide ultraviolet light protection.
 - 5. The optical fiber color coding shall be per EIA/TIA-598-B, "Optical Fiber Cable Color Coding."
- G. Each optical fiber backbone cable shall consist of a minimum number of individual elements specified within the Project Drawings, such as backbone/riser schematics, but shall never be less than 12 strands of fiber.
 - 1. Optical fiber cabling shall be available in 12-, 24-, 48-, and 96-element configurations.
- H. All optical fiber cables shall be shipped with OTDR results for each fiber. OTDR results shall show attenuation and bandwidth. The results shall be documented to retain the information for future use.
- I. Backbone (riser) cable in non-plenum air spaces shall be NEC Type OFNR as follows:
 - 1. Tight buffered Fan-Out Riser Cable.
- J. Backbone (riser) cable in plenum air spaces shall be NEC Type OFNP as follows:

1. Tight buffered Fan-Out Plenum Cable.
 - K. Campus Backbone (Underground & Building Entrance) shall be of loose tube design with water-blocking technology NEC OFNR as follows:
 1. Loose Tube Gel-Free Cable
 - L. Building entrance cables meeting the UL-1666OFNR specification may enter a building without requiring a transition splice, i.e., Loose Tube Gel-Free Cables.
- 2.4 OPTICAL FIBER CONNECTORS
- A. All optical fiber cables shall be terminated with permanently installed connectors per EIA/TIA-45 S-21.
 - B. Optical fiber connections for multimode optical fiber shall utilize "LC" type fusion splice connectors. The max insertion loss is .2 dB.
 - C. Optical fiber connections for single-mode optical fiber shall utilize "ST" type pigtail connectors. Max insertion loss .15 dB. with zirconia ceramic ferrule and bend limiting strain relief
 - D. The connectors shall sustain a minimum of two hundred (200) mating cycles without violating performance requirements as outlined in EIA/TIA 568B.3.
 - E. Connectors shall be color-coded according to the optical fiber type for which they are applied. 9/125µm single mode shall be blue, and laser-optimized 50/125µm OM3 multimode shall be aqua, and OM4 to be Erika Violet.
- 2.5 INNERDUCT
- A. Innerduct shall be riser or plenum rated, as required for the environment in which it is placed.
 - B. Innerduct shall be flexible, corrugated, and non-metallic.
 - C. Innerduct shall be 1-1/4" diameter.
 - D. Innerduct shall NOT be required where optical fiber cabling construction is specified with a jacketed interlocking armor.

PART 3 – EXECUTION

3.1 FIELD CONDITIONS

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other components for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.
- B. Unless otherwise noted, the footage for cabling and materials shown on the Project Drawings are based upon available plant records, Architectural drawings, or the Architect's route and pathway assumptions. The Contractor shall be required to perform field surveys and measurements before ordering materials.
- C. Unless otherwise stated, the more restrictive shall be applied where installation requirements

identified in Reference Standards conflict with the manufacturer's recommendations.

- D. Bring to the attention of the Owner and Architect conflicts between the manufacturer's instructions and Contract Documents.

3.2 OPTICAL CABLE INSTALLATION

- A. The Contractor shall field survey and review with the Owner and Architect similar installations on campus that contain the same type of materials used for this Project to achieve the desired routing and layout, installation techniques, and finished look prior to the start of construction and as often as necessary during the construction process.
- B. Install all cables through primary and secondary pathways. Unless otherwise specified, installation methods and techniques shall satisfy ANSI/EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. Where cables are supported from the building structure, they shall be adequately supported such that the cable will not be damaged by normal building use.
- D. Cables shall not be installed or routed in any manner that violates the manufacturer's specifications. The manufacturer's minimum bend radius for static (post-installation) cables is ten times the cable diameter. The manufacturer's minimum bend radius for cables under strain (pulling tension) is 20 times the cable diameter.
- E. Unless otherwise specified, terminate cables per ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, observing the industry standards for terminating color-coded cables for premises and campus environments.
- F. Do not install damaged or defective cables. Installation of damaged cable will not be accepted. Unless otherwise allowed by the Owner, damaged cable shall be removed and new cable installed at the Contractor's expense. Damage includes physical damage to the cable and damage that may affect performance. The owner will not accept cable of any type until it is installed and passes a physical inspection and all performance tests.
- G. Cable Support along Primary Pathway
 - 1. Primary pathways include major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas, which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.
 - 2. Where the cable tray cannot be installed to be continuous, provide support and strain relief for cables using mechanical fasteners such as J-hooks, conduit, C-channel, and other necessary devices to support cables around discontinuity. In exposed areas, support cables as indicated on the Drawings.
 - 3. Where a telecommunication raceway, cable tray, or cable rack is provided, all telecommunication cables shall utilize the system except:
 - a. Emergency System Wiring
 - b. Fire Alarm Systems
 - 4. Cables shall be routed to avoid crossover between cable continuing vertically floor-to-floor and cable routed horizontally.
 - 5. Cable installation and routes shall be planned, and cables shall be installed so that the capacity of the conduit, sleeves, and cable tray is used most efficiently.
 - 6. Bundle and route cables throughout the building to maintain neat, uniform, and combed bundles. Where cable is exposed in vertical runs, such as utility shafts, provide reusable cable straps to neatly contain cable bundles.
 - 7. Provide strain relief for cables routed vertically using mechanical fasteners such as conduit, C-channel, reusable cable straps, and other necessary devices to support cables.

8. Use common vertical sleeve(s) for routing optical intra-building backbone/riser cables. Provide strain relief for cables routed vertically using mechanical fasteners such as conduit, C- channel, reusable cable straps, and other necessary devices (such as Erico/Caddy #CAT600WM) to support cables.
9. Secure all intra-building backbone cables to the MC and TR walls to prevent cable movement. D-rings shall be acceptable for this purpose.
10. Secure the cables to the Cable Runway to prevent movement and use the horizontal Cable Runway to route the cable to the termination point.
11. Furnish a fifteen (15) foot service loop within all MC and TR locations.

3.3 CABLE MANAGEMENT AND ROUTING AT DISTRIBUTION FRAMES

- A. Cabling shall be arranged by cable number on the patch panels in sequential numerical order.
- B. Cabling shall be arranged on the termination blocks in sequential numerical order by cable pair.
- C. At distribution frames, route cables along the backboard vertically and horizontally to avoid diagonal routing. Where the termination location is unspecified, neatly coil enough cable slack in each closet to reach the farthest corner of the backboard, routing vertically and horizontally.
- D. Plan cable layout, routing, and cable management on the backboard such that:
 1. Cable cross-over is minimal.
 2. Cables are kept as short as practicable.
 3. Station and equipment cables are neatly shaped, combed, and bundled vertically and horizontally.

3.4 OPTICAL CABLE SPLICES

- A. All splices shall be performed in a splice closure specifically designed for the number of cables, size of cables, quantity of conductors, and environment of the splice.
- B. Telecommunications cables' metallic shields (such as protective armor) shall be bonded within the closure of all splices.
- C. All cables entering a splice case shall be supported independent of the splice case to a supporting structure, such that the splice case is accessible for re-entry.

3.5 CABLE REMOVAL

- A. All optical cable and termination hardware that is replaced with new shall be removed.
- B. Conduit and enclosures shall remain. Blank covers shall be provided for abandoned junction boxes.
- C. All penetrations and sleeves affected by cable removal shall be fire-stopped after removal to maintain the required fire rating.
- D. Existing termination hardware within the existing telecommunications spaces and communications enclosures shall be removed from service after cutover.
- E. Existing distribution frame hardware and cabling shall be removed after active services are transferred to the new cabling system, as verified at the frame.

3.6 OPTICAL CABLE INSTALLATION AND ROUTING

- A. The optical fiber cable shall be installed after the complete installation of the inner duct if the inner duct is specified.
- B. All optical fiber cables shall be home-run. Cables shall not be spliced.
- C. The cable shall be installed according to the manufacturer's specifications for installation and loading. The short—and long-term cable loading values shall not be violated.
- D. The manufacturer's minimum bending radius under both loaded and unloaded conditions shall not be violated. Cable wrinkling shall be avoided.
- E. Cable and innerduct routes shall be defined prior to installation so that the cable lengths are accurate, securing cable in place will not result in a shortage of cable, and desired routing paths are not compromised because of inaccurate planning and coordination.
- F. A service loop of 10 feet (minimum) shall be provided at both ends of the cable unless otherwise indicated in the drawings. The location of the service loop shall be placed such that the cable can be extended without interference from other systems such as mechanical systems, electrical piping, plumbing, racking, etc. The direction of the loop (i.e., clockwise or counter-clockwise) shall be such that the cable enters the rack and distribution hardware with minimal bends. The service loop shall be stored out-of-way and fastened to prevent possible damage

3.7 OPTICAL FIBER TERMINATION

- A. General Optical Fiber Termination
 - 1. All Single-mode fiber shall be fusion spliced, fiber-to-fiber, or fiber-to-factory-made jumper with LC connectors. All Single-mode fiber will have LC connectors.
 - 2. Backbone (multimode) optical fiber cables shall be directly terminated with LC fusion splice on connectors. All Single-mode fiber will be fusion spliced to jumpers or pigtails.
 - 3. Cable and fiber protection, installation, and termination shall follow the connector manufacturer's recommended practices. It shall use the manufacturers, kits, processes, cleaners, solvents, fasteners, and other mechanisms necessary for a complete termination unless otherwise indicated.
 - 4. Unless otherwise indicated, all cable routing, management, preparation, protection, installation, and storage shall follow the hardware manufacturer's recommended practices. It shall use the manufacturers, kits, processes, cable and fiber management hardware, fasteners, and other mechanisms necessary for a complete installation.
 - 5. LC connectors shall be used on all Fiber Terminations unless otherwise indicated.
 - 6. The multimode fibers shall be terminated with an aqua connector for OM3 and Erika Violet for OM4. Adapter frames shall match the connector color. The single-mode fibers shall be terminated with a blue connector and inserted into the blue adapter.
 - 7. Cable and fiber terminations shall be labeled. The Contractor shall provide information per Owner-furnished cable recording documents.
 - 8. Cable termination shall incorporate industry-standard color coding and positioning within the enclosures. For adapter orientations, refer to Paragraph 3.8.4.
 - 9. The connector panels that contain the LC adapters shall accommodate six adapters (six fibers). The orientation of the adapters for the desired polarity is described in paragraph 3.8.4.
- B. Optical Fiber Termination Within Rack Mount Patch Panels
 - 1. Coordinate with the Owner and Architect to field review the installation of enclosures and hardware to determine desired installation techniques and placement practices before installing them throughout campus buildings.

2. Install the Patch Panels as shown on the drawings. Unless otherwise indicated, all enclosures shall be installed tight to each other in the equipment racks.
3. The Patch Panels shall be installed with connector panels in a low-density configuration.
4. Install Single-mode and Multimode fibers in separate Patch Panels.

C. Optical Fiber Termination Adapter Orientation

1. The adapters' specific orientation is necessary to maintain the correct polarity of the transmission and receive signals throughout the campus. Polarity is achieved by the physical key slot orientation of adapters in the fiber distribution enclosures. The adapter orientation that shall be applied will be included with the fiber cable recording documents from the Owner and Architect. The key-slot-up or key-slot-down orientation related to the A/B and B/A designation is shown below.
2. Physical orientation of the adapters shall be achieved by removing and rotating the adapter within the connector panel to the proper key-slot-up or key-slot-down
3. The Owner will furnish adapter orientation information in the following tabular form. Refer to the Table below.

Cable Identifier	Space Identifier with Cable End 1	Adapter Orientation	Space Identifier with Cable End 2	Adapter Orientation

3.8 FIRESTOPPING

- A. Fire-stopping shall be installed after all cabling under contract has been installed. Refer to Specification Section 270500 Common Work Results for Communications

3.9 OPTICAL FIBER TESTING AND DOCUMENTATION PROCEDURES

A. End-to-End Attenuation Testing per Segment

1. The following guidelines apply to test procedures and shall be followed to promote efficient and accurate testing:
 - a. Test jumpers shall be the same fiber, fiber core size, and connector type as the tested cable.
 - b. The power meter and the light source shall be set to the same wavelength.
 - c. All system optical connectors, sleeves, and jumpers shall be adequately cleaned before measurement.
2. The optical power loss in the optical fiber shall be measured for each segment of optical fiber cable by performing end-to-end attenuation testing of cable segments.
3. End-to-End Attenuation Test Requirements:
 - a. Testing shall be performed on all optical fibers in all cables.
 - b. Each cable shall be tested end to end.
 - c. All testing shall be performed after the optical fiber cable is installed in its final resting place, after buffer tubes, pigtails, and fiber strands are routed and secured in their final resting place, and after all optical fiber strands are terminated with connectors and inserted into the adapters in the connector panels within the enclosures.
 - d. All measurements and recordings shall be performed with the optical source at the entrance facility.
4. Multimode Optical Fiber - End-to-End Attenuation Test Procedure:
 - a. Perform the test at both 850 nm and 1300 nm.
 - b. Testing shall be performed in one direction.
 - c. Tests shall be performed with an optical source and optical power meter.

- d. The test procedure is ANSI/EIA/TIA-526-14A-Test Method B, Optical Power Loss Measured of Installed Multimode Fiber Cable Plant.
 - e. Identify unsolvable discrepancies to the Owner and Architect.
- 5. Single Mode Optical Fiber - End-to-End Attenuation Test Procedure:
 - a. Perform the test at both 1310 nm and 1550 nm.
 - b. Testing shall be performed in one direction.
 - b. Tests shall be performed with an optical source and optical power meter.
 - c. The test procedure that shall be used is ANSI/EIA/TIA-526-7-Test Method A.1, Optical Power Loss Measured of Installed Single-mode Fiber Cable Plant
 - d. Identify unsolvable discrepancies to the Owner and Architect.
- 6. End-to-End Attenuation Test Result Analysis:
 - a. In the field with the test gear in place, compare the test result with the expected optical power loss from the Owner-furnished table. Troubleshoot and correct for results outside the expected range, and when the results prove inconsistent, retest. This is an iterative process.
 - b. Notify the Owner and Architect of test results that are out of range for reasons other than installation practices.
- 7. End-to-End Attenuation Test Documentation:
 - a. The Test Documentation requirements are the minimum requirements. Other details of presentation and recording methods will be discussed with the Owner and Architect. Gain approval from the Owner and Architect of the test documentation format and content prior to campus-wide testing. Coordinate with the Owner and Architect to get a representative sample of the documentation format and content for review.
 - b. Provide the Owner with a printed copy of the test results and the electronic files on disk.
 - c. The Contractor shall provide the test data in a complete, consistent, and tabular format. All results shall be printed from a laser printer.
 - d. Provide the printed results paper-clipped together in numerical order by building fiber cable number. The tab label shall indicate ONLY the cable number on a laser-printed label.

B. Signature Traces (Single Mode Optical Fiber Only)

- 1. The signature trace shall not be required under this Contract.

3.10 WIRE AND CABLE IDENTIFICATION

- A. Furnish and install labels as identified in Specification Section 270553 Identification for Communication Systems.

END OF SECTION 27 13 23

SECTION 27 15 13
COMMUNICATIONS COPPER/OPTICAL FIBER HORIZONTAL CABLING

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1123 – Communications Cable Management and Cable Runway
- J. Section 27 1313 – Communications Copper Backbone Cabling
- K. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- L. Section 27 1543 – Communications Faceplates and Connectors
- M. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 270000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SYSTEM DESCRIPTION

- A. Communications Copper Horizontal Cabling shall be furnished, installed, tested, labeled, and documented from each MC (Main Cross-Connect) or TR (Telecommunication Closet) to all WAOs (Work Area Outlets), TO (Telecommunications Outlets), and EO (Equipment Outlets) ready for connection of file servers, personal computer stations, telephones, medical equipment, wireless access points, video control interfaces, monitoring interfaces, printers, modems, and all other equipment as designated by the Owner.
- B. Category 6a Communications Copper Horizontal Cabling shall be sourced from and certified by the following approved termination hardware manufacturer(s) per project site.

1. BELDEN

1.4 DEFINITIONS

- A. Refer to Section 270000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 270000 – Communications General

1.6 SUBMITTALS

- A. Refer to Section 270000 – Communications General
- B. Product Data Sheets
- C. Specification Sheets for Test Equipment
 - 1. Hand-held testing equipment manufacturer, model, and software version.
 - 2. Injector equipment manufacturer, model, and software version.
- D. Bill of Materials
- E. Contracting Firm Qualifications and Certifications
- F. Current Manufacturer Certifications
- G. 100% Test Results as detailed within PART 3 EXECUTION

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Cables from the approved list as maintained by the termination hardware manufacturer for the solution proposed:
 - 1. BELDEN

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 -Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 COPPER HORIZONTAL CABLING

- A. The Horizontal System is the portion of the telecommunications cabling system that extends from the TO (Telecommunications Outlet) connector to the HC (Horizontal Cross-connect), located in the MC (Main Cross-Connect) or TR (Telecommunications Room). It consists of the

telecommunications outlet/connector, horizontal cables, optional CP (Consolidation Point) if indicated in the Project Drawings, and cross-connect portion in the MC/TR serving the horizontal cabling. Each building floor should be served by a distinct Horizontal System unless otherwise directed by the Owner.

1. Horizontal cabling shall be TIA 568.C.2 Class E performance rated Category 6a. The manufacturer shall imprint all cables as Category 6a, at minimum.
2. All cabling shall consist of four (4) unshielded twisted pairs, non-bonded solid bare copper conductors, color-coded per the band strip color coding conventional standard as follows:
 - a. Pair #1 - White/Blue-Blue
 - b. Pair #2 - White/Orange-Orange
 - c. Pair #3 - White/Green-Green
 - d. Pair #4 - White/Brown-Brown
3. All Horizontal system cables shall be CMP. These markings shall also include the cable manufacturer's name and the category performance rating.
4. Cable jackets shall be sequentially marked at 2-foot intervals.
5. Horizontal cabling shall be white.
6. Physical Characteristics
 - a. Gauge: 23 AWG
 - b. Cable Diameter: .247"
 - c. Nominal Weight: 34 lbs./kft.
 - d. Max. Install Tension: 45 lbs.
 - e. Min. Bend Radius: 1.5"
 - f. Operating Temperature: -20° to +75°C
7. Performance Characteristics
 - a. Mutual Capacitance: 15.4pF/ft. nom., 330pF/100m max.
 - b. DC Resistance: 6.6 ohms/100m
 - c. Skew: 25ns/100m
 - d. Nom. Velocity of Propagation. (NVP): 70% max.
 - e. Cabling shall exhibit the following minimum performance characteristics at the following frequencies:

Parameter	100MHz (dB)	200MHz (dB)	250MHz (dB)	400MHz (dB)	500MHz (dB)
Max. Insertion Loss	20.9	30.1	33.9	43.7	49.3
Min. NEXT Loss	44.3	39.8	38.3	35.3	33.8
Min. PSNEXT Loss	42.3	37.8	36.3	33.3	31.8
Min. ACR	27.8	21.8	19.8	15.8	13.8
Min. PSACRF	24.8	18.8	16.8	12.8	10.8
Min. Return Loss	12.0	9.0	8.0	6.0	6.0

Category 6a Minimum Cable Performance Standards

- B. Contractor shall provide the Owner with an estimate of the quantities of the required BELDEN materials.
- C. Communications cables shall be type and size (number of pairs) identified for the installation of the various communications systems.
- D. Communications cables shall be UL Listed and Approved for intended use. All cables shall be of the Type specified by the NEC for use in plenum, non-plenum, and riser spaces.
- E. Communications cables installed in cable trays or racks shall be approved for use in such and shall be of fire-resistive construction.

- F. Communications cable suitable for use in ducts, plenum, and other space used for environmental air shall be UL Listed as being smoke resistant, shall be Teflon-coated and shall be classified as type CMP communications cable.
- G. Communications cable suitable for use in vertical shafts shall be UL Listed for use in such space and shall be classified as type CMR communications cable

2.4 OPTICAL FIBER HORIZONTAL CABLING

- A. New segments of multi-element optical fiber backbone cable shall meet the requirements of the National Electrical Code® (NEC)® Section 770. The cable shall be listed as OFNR (OFCR) for riser (non-plenum) applications or OFNP (OFCP) for plenum applications, as required. The indoor backbone fiber shall be multi-mode and single-mode, utilizing a tight buffered, air-core design with all-dielectric strength member construction.
- B. Minimum bend radius shall be no less than fifteen (15) times outside diameter under full tensile load and no less than ten (10) times outside diameter under no load.
- C. New Multi-mode Optical Fiber segments shall meet the requirements of EIA/TIA-492AAAC "Detail Specification for 850-nm Laser-Optimized, 50µm Core Diameter/125µm Cladding Diameter Class 1a Graded-index Multimode Optical Fibers."
- D. Color Coding
 - 1. For indoor applications, the color of the outer jacket shall be aqua for cables containing 50/125 µm OM3 Laser Optimized Fiber and Erika Violet for OM4
 - 2. For indoor applications, the outer jacket of cables containing single-mode fiber shall be yellow.
- E. Each optical fiber backbone cable shall consist of a minimum number of individual elements specified within the Project Drawings, such as backbone/riser schematics.
- F. Optical fiber cabling shall be available in a 2-element configuration.
- G. All optical fiber cables shall be shipped with OTDR results for each fiber. OTDR results shall show attenuation and bandwidth. The results shall be documented in such a manner that the information can be retained for future use.
- H. Backbone (riser) cable in non-plenum air spaces shall be NEC Type OFNR as follows:
 - 1. Tight buffered Fan-Out Riser Cable.
- I. Backbone (riser) cable in plenum air spaces shall be NEC Type OFNP as follows:
 - 1. Tight buffered Fan-Out Plenum Cable.

2.5 OPTICAL FIBER CONNECTORS

- A. All optical fiber cables shall be terminated with permanently installed connectors per EIA/TIA-45 S-21.
- B. Optical fiber connections for multimode optical fiber shall utilize "LC" fusion splice on type connectors mounted in frames
- C. Optical fiber connections for single-mode optical fiber shall utilize "ST" type fusion splice pigtail connectors mounted in splice cassettes.

- D. The maximum optical attenuation for each rated connector pair shall not exceed 0.2dB for OM3/4 and .35 dB for ST Pigtails.
- E. The connectors shall sustain at least two hundred (200) mating cycles without violating performance requirements as outlined in EIA/TIA 568B.3.
- F. Connectors shall be color-coded according to the optical fiber type for which they are applied. 9/125µm single mode shall be blue, and laser-optimized 50/125µm OM3 multimode shall be aqua; OM4 Erika Violet

PART 3 – EXECUTION

3.1 FIELD CONDITIONS

- A. Examine all elements intended for Communications. Check pathways, raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, installation hazards or impediments, and other conditions affecting installation. Verify that all work required in the field is adequately described in the plans. Proceed with installation only after unsatisfactory conditions and discrepancies have been brought to the attention of the General Contractor or Construction Manager and corrected.
- B. Unless otherwise noted, the footage for cabling and materials shown on the Project Drawings are based upon available plant records, Architectural drawings, or the Architect's route and pathway assumptions. The Contractor shall be required to perform field surveys and measurements before ordering materials.
- C. Unless otherwise stated, where installation requirements identified in Reference Standards conflict with the manufacturer's recommendations, the more restrictive shall be apply.
- D. Bring to the attention of the Owner and Architect conflicts between the manufacturer's instructions and Contract Documents.

3.2 CABLE INSTALLATION

- A. The Contractor shall field survey and review with the Owner and Architect similar installations on campus that contain the same type of materials used for this Project to achieve the desired routing and layout, installation techniques, and finished look prior to the start of construction and as often as necessary during the construction process.
- B. Install all cables through primary and secondary pathways. Unless otherwise specified, installation methods and techniques shall satisfy ANSI/EIA/TIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.
- C. Where cables are supported from the building structure, they shall be adequately supported such that the cable will not be damaged by normal building use.
- D. Horizontal station cables shall be home-run from the communication outlet box at the work area to the distribution frame serving the area as shown on the Drawings. Horizontal copper cabling runs shall be placed in one continuous end-to-end length between the MC or TR and the WAO, TO, or EO without splices of any kind.
- E. Cables shall not be installed or routed in any manner that violates the manufacturer's specifications. Manufacturer's minimum bend radius for static (post installation) cables is 10 times the cable diameter. Manufacturer's minimum bend radius for cables under strain (pulling tension) is 20 times the cable diameter.

- F. Unless otherwise specified, terminate cables in accordance with ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard, observing the industry standards for terminating color-coded cables for premises and campus environments.
- G. Do not install damaged or defective cables. Installation of damaged cable will not be accepted. Unless otherwise allowed by the Owner, damaged cable shall be removed and new cable installed at the Contractor's expense. Damage includes physical damage to the cable and damage that may affect performance. The owner will not accept cable of any type until it is installed and passes a physical inspection and all performance tests.
- H. Cable Support along Primary Pathway
1. Primary pathways include major pathways for cable routed floor-to-floor, through corridors, and pathways that carry cables feeding multiple areas, which are likely to be used to support growth in those areas. Primary pathways carry cable to secondary pathways.
 2. Where the cable tray cannot be installed to be continuous, provide support and strain relief for cables using mechanical fasteners such as J-hooks, conduit, C-channel, and other necessary devices to support cables around discontinuity. In exposed areas, support cables are indicated on the Drawings.
 3. Where a telecommunication raceway, cable tray, or cable rack is provided, all telecommunication cables shall utilize the system except:
 - a. Emergency System Wiring
 - b. Fire Alarm Systems
 4. Cables shall be routed to avoid crossover between cable continuing vertically floor-to-floor and cable routed horizontally.
 5. Cable installation and routes shall be planned, and cables shall be installed so that the capacity of the conduit, sleeves, and cable tray is used most efficiently.
 6. Bundle and route cables throughout the building to maintain neat, uniform, and combed bundles. Where cable is exposed in vertical runs, such as utility shafts, provide reusable cable straps to neatly contain cable bundles.
 7. Provide strain relief for cables routed vertically using mechanical fasteners such as conduit, C-channel, reusable cable straps, and other necessary devices to support cables.
 8. Cables may NOT be stapled permanently, held, or fastened at any point along the primary pathway.
- I. Cable Support Along Secondary Pathway
1. Secondary pathways extend from the primary pathway to the communication outlet box and carry cable from the primary pathway to the communication outlet box.
 2. Cable shall be routed parallel and perpendicular to walls and floors from the primary pathway to the outlet box. Multiple routes are possible, and the cable should be routed along the shortest path to minimize cable length as practicable.
 3. Attaching or otherwise draping cables to ceiling wire grids, pipes by other trades, lighting fixtures, etc., shall not be permitted.
 - a. Do not use suspended ceiling support hangers (wires) to support station cables.
 - b. Do not support cables from other mechanical, electrical, or plumbing systems.
 - c. Station cables shall be supported so they do not rest on the suspended ceiling system.
 4. The building structure shall support cables and cable pathways. A superstructure designed and intended to support multiple utilities may be used as a superstructure for communications cables if the superstructure can physically support the additional load and if the support mechanism for the cable works for supporting the cable from the superstructure
 5. J-Hooks and other independent cable supports shall be located at 48" to 60" centers to adequately support and distribute the cable weight.
 6. The Contractor shall determine the route and quantity of J-Hooks and other independent cable supports within the overhead ceiling space wherein cable tray or other support systems have not been provided by Division 26.
 7. Where J-Hooks and independent cable supports are used, runs shall follow walls and

building supporting structures; diagonal runs are unacceptable.

8. Place cables without exceeding the cable manufacturer's recommended pulling tensions.
9. Pull cables simultaneously if more than one is pulled in the same raceway.
10. Use pulling compound or lubricant only if necessary. Use compounds that will not damage the conductor or insulation.
11. Use pulling means, including fish tape, cable, rope, and basket weave or cable grips that will not damage cabling or raceways.
12. Cables may NOT be stapled permanently, held, or fastened at any point along a secondary pathway.

3.3 CABLE BUNDLING HARDWARE

- A. Cable bundling hardware shall be rated for the environment and application used. Applications include but are not limited to, general purpose, outdoor, chemical resistant, flame retardant, high temperature, and vibration.
- B. Provide reusable cable management straps for bundling and securing horizontal station cables and equipment jumper cables within entrance facilities and telecommunication closets. Do not use nylon cable ties.
- C. Provide reusable cable management straps for bundling and securing horizontal station cables at primary vertical pathways. Do not use nylon cable ties.
- D. Do NOT strap horizontal station cable to cable tray and ladder rack.

3.4 CROSS-CONNECT JUMPERS

- A. Coordinate installation of jumpers with the Owner before starting work.
- B. Provide a 2" minimum and 4" maximum service loop in each cross-connect jumper for voice and data circuits at each end.
- C. Cross-connect jumpers shall be uniform in shape.
- D. Plan and route cross-connect jumpers for voice and data circuits through the jumper rings on the frames so that they are not intermixed haphazardly. Keep voice and data cross-connect jumpers as segregated as possible.

3.5 CABLE MANAGEMENT AND ROUTING AT DISTRIBUTION FRAMES

- A. Cabling shall be arranged by cable number on the patch panels in sequential numerical order.
- B. Cabling shall be arranged on the termination blocks in sequential numerical order by cable pair.
- C. At distribution frames, route cables along the backboard vertically and horizontally to avoid diagonal routing. Where the termination location is unspecified, neatly coil enough cable slack in each closet to reach the farthest corner of the backboard, routing vertically and horizontally.
- D. Plan cable layout, routing, and cable management on the backboard such that:
 1. Cable cross-over is minimal.
 2. Cables are kept as short as practicable.
 3. Station and equipment cables are neatly shaped, combed, and bundled vertically and horizontally.

3.6 COPPER CABLE SPLICES

- A. Horizontal station cables shall not be spliced.

3.7 CABLE REMOVAL

- A. If applicable, the horizontal station cable and termination hardware that are replaced with new shall be removed.
- B. The existing twisted pair communications cable and hardware in the project area that was abandoned prior to this Project shall be removed.
- C. Conduit and enclosures shall remain. Blank covers shall be provided for abandoned outlet boxes.
- D. After the cable is removed, all penetrations and sleeves affected shall be fire-stopped to maintain the required fire rating.
- E. Existing termination hardware within the existing telecommunications spaces and communications enclosures shall be removed from service after cutover.
- F. Existing distribution frame hardware and cabling shall be removed after active services are transferred to the new cabling system, as verified at the frame.

3.8 WIRE AND CABLE IDENTIFICATION

- A. Furnish and install labels as identified in Specification Section 270553 Identification for Communication Systems.

3.9 FIRE-STOPPING

- A. Fire-stopping shall be installed after all cabling under contract has been installed. Refer to Specification Section 270500 Common Work Results for Communications

3.10 UTP TESTING AND DOCUMENTATION PROCEDURES

A. General

1. This Section includes link and channel testing methods, procedures, and minimum transmission requirements for the unshielded twisted pair (UTP) Category 6a-rated cable systems installed under this Project.
2. The testing aims to ensure proper installation of the UTP telecommunications cabling system.
3. Unless otherwise specified herein, all testing definitions, parameters, methods, and practices shall comply with the Performance Standards identified in Specification Section 270000 Communications General.
4. Unless otherwise indicated, a field link test shall be performed on new horizontal cables installed under the Project and on existing horizontal wires that are re-terminated, rerouted, and where the termination is disturbed to perform work under the project.
5. Unless otherwise indicated, a field channel test shall be performed ONLY on outlet locations receiving data service. The outlets to receive data service are identified on the Owner-provided cutover cable records. The channel test for locations receiving data service is in addition to the link test for the area.
6. Two weeks (14 days) prior to the scheduled cutover date, the Owner shall receive printed copper station cable performance test results from the Contractor. Cutover shall not commence unless test results are submitted.

B. Link Definition for the Project

1. A link consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 2 meters of test equipment lead from the main unit of the hand-held tester to the local

- connection, and up to 2 meters of test equipment lead from the remote unit to the remote connection, for a total length of up to 94 meters (308 feet).
 2. The connection to the equipment at each end of the link is not included in the link definition.
- C. Channel Definition for the Project
1. A channel consists of up to 90 meters (295 feet) of horizontal cabling, a connection at each end, up to 7 meters for the cross-connect and equipment cable, and up to 3 meters for the work area equipment cable. A total length of up to 100 meters (328 feet)
 2. The connection to equipment at each end of the channel is not included in the channel definition.
- D. Field Tests to be Performed:
1. The following field tests shall be performed for both the link and the channel for category-6a performance:
 - a. Wire Map
 - b. Length
 - c. Attenuation
 - d. Near-end Crosstalk (NEXT) Loss
- E. Test Equipment:
1. Test equipment shall have the most current software upgrades to meet applicable testing standards. The testing instruments' calibration shall be current as per the manufacturer's requirements. Test cords, adapters, and connectors shall be maintained in good order. Test instruments must be identified on the applicable summary test forms to make, model, software generic, and date calibration.
 2. This Contractor may be required to field demonstrate the calibration and testing procedures to the Owner. The Owner shall confirm the demonstration requirement before the start of field test operations
 3. Unless pre-approved by the Owner, all copper certification testing shall be performed using test equipment as follows:
- F. Test Equipment Setup and Test Parameters:
1. Autotest: Use the "Cat6 Link Full" and "Cat6 Channel Full" Autotests from the Autotest List to perform the required link and channel tests. Customize the Autotest as necessary to satisfy testing requirements and parameters.
 2. Cable Type: Select the cable type being tested. Cable Type may vary. Always change the NVP identified herein for the cable being tested.
 3. NVP: The Nominal Velocity of Propagation (NVP) shall be determined by field measuring a 150-foot piece of cable according to the manufacturer's instructions. The cable shall be unspooled and physically measured with a tape measure. Do not use footage markings on the cable to determine 150 feet.
 4. The cable shall be terminated on both ends with an 8-pin modular jack.
 5. The PentaScanner+ calculates the NVP based on the cable's shortest wire pair. The NVP shall be printed on the test report.
 6. Frequency Range: The frequency range for category 6A tests shall be 1 MHz to 500 MHz. The default frequency range of the Category 6A Permanent Link and Category 6A Channel Autotest is 1 MHz - 500 MHz.
 7. Cable Pairs: Test all cable pairs. Select all pairs for TEST and Pass/Fail criteria for Autotest.
 8. Length Units: Cable length test results shall be in feet.
 9. Date Style: The date style shall show month, day, and year, and the date shall be the date the test is conducted.
 10. Language: English.
- G. Test Procedure
1. The Contractor shall provide 48 hours' notice to the Owner and Architect before the commencement of cable testing. The Architect shall, at his discretion, be present to observe

- any cable test procedures, which shall be acceptable to the Architect.
- 2. Testing shall be performed with the tester at the distribution frame and the injector at the work area outlet.
- 3. All tests shall be performed with connectors, and termination will be completed and in place.
- 4. Test leads and test hardware have limited life cycles.
- 5. Inspect and replace the test leads as necessary.
- 6. Use only test leads specified by the test equipment manufacturer.
- 7. Strictly follow the test equipment manufacturer's instructions for equipment setup, initialization, and calibration.
- 8. Cables or components not satisfactorily passing the tests described or failing to meet quality installation standards described in this specification shall be repaired and replaced at the Contractor's expense.

H. Test Documentation

- 1. The Test Documentation requirements are the minimum requirements. Other details of presentation and recording methods will be discussed with the Owner and Architect. Before full-scale testing, gain approval from the owner and architect for the test documentation format and content. Coordinate with the Owner and Architect to get a representative sample of the documentation format and content for review.
- 2. Provide the Owner with both a printed copy and the test results' electronic files on disk.
- 3. The test report shall include the information shown in the Appendix-A sample unless otherwise approved by the Owner and Architect. The italicized information on the report is example information and is variable. Customize the information for the particular installation.
- 4. Printed copy shall include the following header fields on each test report, which shall contain the appropriate information. These are the minimum requirements:
 - a. Circuit ID
 - b. Test Result
 - c. Owner
 - d. Serial Number
 - e. Injector Serial Number
 - f. Software Version
 - g. Date
 - h. Cable Type
 - i. NVP
 - j. Building
 - k. Closet (MC or TR)
- 5. The information in each user-definable header field on each test report shall contain the information as follows:
 - a. Circuit ID: Indicate the outlet location number and jack number under test
 - b. Owner: Indicate the Owner of the test equipment
 - c. Date: Indicate the date of the test
 - d. Cable Type: Indicate the cable type being tested
 - e. NVP: Indicate the field measured NVP
 - f. Building: Indicate the building where the cable is being tested
 - g. Closet: Indicate the closet identifier where the cable is terminated
- 6. The minimum test result information on each report shall include the data for the tests identified in "Field Tests Performed".
- 7. The Contractor shall provide the test data in a complete and consistent format. All results shall be printed from a laser printer.
- 8. Provide the printed results contained in 3" three-ring notebook binders. The test results shall be three-hole punched and numerically ordered by outlet location number within the notebook. Provide separate notebooks for Channel Test results and Link Test results. Multiple volumes may be necessary. Separate all FAIL test results from the PASS test results in each notebook. Provide a separator tab labeled "Fail Results" in front of the sheets of FAIL test results. Provide a separator tab labeled "Pass Results" in front of the sheets of PASS test results.

9. The cover of the notebook shall read (*italicized information is variable*):
 - a. "PROJECT NAME"
 - b. "Building Name "(BLDG. No. x)"
 - c. "UTP Test Results"
 - d. "Volume No." X
 - e. "Date" (month and year)
10. The Contractor shall verify that the notebooks contain a report for each jack in the Project.
11. The electronic copy of the test results shall be on DVDs.
12. DVDs shall be labeled. The label shall read:
 - a. "PROJECT NAME"
 - b. "Building Name (BLDG. No. x)"
 - c. "UTP Test Results on Disk"
 - d. "Disk No." X of x
 - e. "Date" (month and year)
13. The files on disk shall be in Comma Separated Variable (CSV) file format.

END OF SECTION 27 15 13

SECTION 27 15 43
COMMUNICATIONS FACEPLATES AND CONNECTORS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and
- B. Division 01 Specification Sections, apply to this Section
- C. Section 27 0000 – Communications General
- D. Section 27 0500 – Common Work Results for Communications
- E. Section 27 0526 – Grounding and Bonding for Communications
- F. Section 27 0528 – Pathways for Communications
- G. Section 27 0553 – Identification for Communications Systems
- H. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- I. Section 27 1119 – Communications Termination Blocks and Patch Panels
- J. Section 27 1123 – Communications Cable Management and Cable Runway
- K. Section 27 1313 – Communications Copper Backbone Cabling
- L. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- M. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- N. Section 27 1619 – Communications Patch Cords, Station Cords, and Cross-Connect Wire
- O. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 270000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SUMMARY

- A. This Section includes:
 - 1. Faceplates and Housings for Work Area Outlets (WAO), Telecommunications Outlets (TO), and Equipment Outlets (EO).
 - 2. Modular Jacks and Outlets for termination of data and voice cabling at WAOs, TOs, and EOs.

1.4 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.6 SUBMITTALS

- A. Refer to Section 27 0000 – Communications General
- B. Product Data Sheets
- C. Specification Sheets for Test Equipment
- D. Bill of Materials
- E. Contracting Firm Qualifications and Certifications
- F. Installation Team Qualifications by Individual
- G. Current Manufacturer Certifications
- H. 100% Test Results as detailed within PART 3 - EXECUTION

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies before bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 FACEPLATES

- A. Furnish and install single-gang modular cover plates with one (1) modular outlet opening for “Voice-Only” or “Data-Only,” as indicated on the Project Drawings.
- B. Furnish and install single-gang modular cover plates with two (2), three (3), and four (4) modular outlet openings for “Voice” and “Data” as indicated on the Project Drawings.
- C. Modular cover plates shall be plastic or stainless steel as required to match electrical plates supplied by Division 26 unless otherwise directed by the Owner. Plastic modular furniture cover plates shall match the furniture’s kick plate color when possible. Confirm all colors with the Owner before ordering materials.
- D. Furnish and install 106-style modular mounting frames where required to adapt to surface raceway as may be provided by Division 26.

- E. Furnish and install blank inserts for all unused openings. Blank inserts shall be International White in color unless otherwise directed by the Owner.

2.4 MODULAR CONNECTORS (JACKS/OUTLETS)

- A. Furnish and install Modular Connectors consisting of RJ45 8-position modular jacks, meeting or exceeding transmission performance of Category 6a.
- B. Modular Connectors shall be mounted in modular cover plates.
- C. Modular Connectors shall be UL-listed and comply with EIA/TIA 568BA.
- D. All modular jacks shall be blue where purposed for “data” and red where purposed for “voice” unless otherwise directed by the Owner. Confirm all colors with the Owner before ordering materials.
- E. Furnish and install keystone-style jacks as may be required to be compatible with special assemblies, such as poke-thru assemblies provided by Division 26.
- F. Apply Blank Inserts to all unused openings. Blank inserts shall be International White in color.

2.5 MODULAR JACK/OUTLET PLATE FOR WALL TELEPHONES

- A. Flush-mounted modular RJ11 jack/plate to fit into a single gang 3-1/2 inch deep box.
- B. RJ11 modular jack shall be 6-position.
- C. The RJ11 jack shall be mounted in a stainless steel faceplate designed for modularly mounting wall telephones.

2.6 MULTIMEDIA OUTLET BOX

- A. Furnish and install a 6-port box, International White in color.
- B. Equip with RJ45 modular connectors.

2.7 MULTI-USER OUTLET BOX

- A. Furnish and install 24-port box, International White in color.
- B. Equip with RJ45 modular connectors.

2.8 SURFACE MOUNT BOXES

- A. Furnish and install a single-port surface-mount box where Telecommunications Outlets are to be provided for Wireless Access Points (WAPs) and IP-based Camera locations.

PART 3 – EXECUTION

3.1 COORDINATION

- A. Confirm colors and identification schemes for cabling, faceplates, and Data/Voice Modular Copper Jacks and Connectors with the Architect and Owner before placing material orders. The Architect must approve requested changes that do not comply with Drawings and Specifications.

- B. The Division 26 contractor shall provide conduit, in-wall boxes, and floor boxes. The Division 27 Contractor shall coordinate with Division 26 to confirm that proper box sizes are provided.
- C. The Division 26 Contractor shall provide the Surface Raceway, where indicated. The Division 27 Contractor shall coordinate with the Division 26 Contractor to confirm that proper box styles and sizes are provided.

3.2 INSTALLATION

- A. Install products per the manufacturer's written instructions and fully comply with the National Electrical Code and other state and local requirements.
- B. The quantity of horizontal station cables to install at each outlet location is keyed to the outlet symbol on the drawings.
- B. For horizontal station cables, terminate each 4-pair cable component with a new 4-pair, 8-position, 8-conductor, T568A pin/pair assignment designation, and UTP modular jack. Install a new faceplate and label each outlet.
- D. Install 2-position faceplates unless otherwise specified herein or indicated on the Drawings.
- E. Faceplates shall be installed flush to the wall surface without gaps, cleaned, and leveled before final acceptance.
- F. All faceplates shall be labeled using machine-generated type in alphanumeric order according to the Owner's labeling scheme and published in a bulletin before installation. The bulletin shall not incur additional cost to the project under any circumstances.
- G. Replacement of damaged system components shall be the Contractor's responsibility.

3.3 CERTIFICATION TESTING

- A. Refer to Specification Section 271513 Communications Copper Horizontal Cabling, Part 3 – Execution.

3.4 WIRE AND CABLE IDENTIFICATION

- A. Furnish and install labels as identified in Specification Section 270553 Identification for Communication Systems.

END OF SECTION 27 15 43

SECTION 27 16 19
COMMUNICATIONS PATCH CORDS, STATION CORDS & CROSS-CONNECT WIRES

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1123 – Communications Cable Management and Cable Runway
- J. Section 27 1313 – Communications Copper Backbone Cabling
- K. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- L. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- M. Section 27 1543 – Communications Faceplates and Connectors
- N. Section 27 3223 – Voice Communications Elevator Telephones

1.2 CODES AND STANDARDS

- A. Refer to Section 270000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SUMMARY

- A. This Section includes:
 - 1. Patch Cables for Backbone Cabling Systems
 - 2. Patch Cables for Horizontal Cabling Systems

1.4 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.6 SUBMITTALS

- A. Refer to Section 27 0000 – Communications General
- B. Product Data Sheets
- C. Bill of Materials

1.7 MATERIALS FOR USE BY OWNER

- A. Furnish materials as described in Part 2 Products.
- B. Throughout the project lifecycle, all cords and jumper assemblies shall be securely stored at the Division 27 Contractor's office facility. When called for by the Owner, materials shall be delivered by the Division 27 Contractor who shall obtain a signature of acceptance and delivery from the Owner.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. Belden

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 270000 Communications General, Part 2 - Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 COPPER PATCH/STATION CORDS – MC and TR – WAO, TO, and EO

- A. Category 6a, 23 AWG 8-conductor stranded copper patch cords with RJ45 plugs.
 - 1. Provide 100% of the total port count of Category 6a “data” patch cords required for patching at the TR (Telecommunications Room) locations. Mix the budget lengths according to 5' and 7' as needed to dress the rack design shown in the Project Drawings evenly.
 - 2. Provide 100% of the total port count Category 6a “data” patch cords for each modular cover plate at the user end. Each patch cord shall be used for connecting to workstations and shall not be less than 9' in length.
 - 3. Patch cables for “data” shall be blue.
- B. Patch cords shall be factory terminated.

- C. All patch cords shall be configured with straight-through pinning with T568B pin-pair configuration.
- D. Patch cords shall not degrade the required channel performance characteristics specified in EIA/TIA 568B.2.
- E. Copper patch cords shall be supplied as a part of the manufacturer's proposed solution.

PART 3 – EXECUTION

3.1 The Contractor shall provide all Patch Cables.

- A. The Contractor shall provide one 15' patch cord for every jack installed at the user interface.
- B. The Contractor shall provide one patch cord for every cable terminated in the ER/TR. (lengths to be determined by location with termination and active equipment 4', 7', 10', 15 are approved)

END OF SECTION 27 16 19

SECTION 27 21 00
DATA COMMUNICATIONS NETWORK EQUIPMENT

PART 1 – GENERAL

1.1 SUMMARY

- A. Section includes network electronics and related accessories for the project data communications network, including:
 - 1. Routers and gateway devices.
 - 2. Layer 2 and Layer 3 Ethernet switches.
 - 3. Power over Ethernet switches.
 - 4. Wireless access points.
 - 5. Wireless LAN controllers, cloud management licenses, or management appliances where required.
 - 6. Network optics, transceivers, stacking cables, mounting hardware, patch cords, power supplies, and accessories required for a complete operating system.
 - 7. Voice-over-IP telephony system extension from the campus headend.
 - 8. Configuration, labeling, testing, documentation, and owner training.
- B. Network electronics shall support Owner's data, voice, wireless, audiovisual, security, building automation, and other IP-connected systems as indicated on the Drawings.
- C. Coordinate with the Owner's information technology representative prior to procurement, configuration, installation, testing, and commissioning.

1.2 RELATED SECTIONS

- A. Section 27 05 00 – Common Work Results for Communications.
- B. Section 27 05 26 – Grounding and Bonding for Communications Systems.
- C. Section 27 05 28 – Pathways for Communications Systems.
- D. Section 27 05 53 – Identification for Communications Systems.
- E. Section 27 10 00 – Structured Cabling.
- F. Section 27 11 00 – Communications Equipment Room Fittings.
- G. Section 27 15 00 – Communications Horizontal Cabling.
- H. Section 28 00 00 – Electronic Safety and Security, where IP security devices connect to network electronics.
- I. Division 26 – Electrical, for power, grounding, surge protection, and UPS coordination.

1.3 REFERENCES

- A. Comply with the latest adopted editions of applicable standards, including:
 - 1. IEEE 802.3 – Ethernet.
 - 2. IEEE 802.1Q – VLAN tagging.
 - 3. IEEE 802.1X – Port-based network access control.
 - 4. IEEE 802.11 – Wireless LAN standards.
 - 5. TIA/EIA structured cabling standards applicable to the project.

6. BICSI TDMM recommendations applicable to telecommunications spaces and pathways.
7. UL, FCC, and applicable local code requirements.

1.4 SYSTEM DESCRIPTION

- A. Provide enterprise-grade network electronics suitable for continuous operation in institutional, commercial, or campus environments.
- B. Equipment shall be compatible with Owner's existing network architecture, management platform, authentication systems, VLAN structure, IP addressing scheme, cybersecurity policies, and monitoring tools.
- C. Network electronics shall support:
 1. Segmented VLAN architecture.
 2. Quality of Service for voice, video, audiovisual, security, and building systems traffic.
 3. Redundant uplinks where indicated.
 4. Secure management access.
 5. Centralized monitoring and configuration backup.
 6. Power over Ethernet for connected devices where required.
 7. SNMP, syslog, NTP, SSH, HTTPS, and other Owner-required management protocols.

1.5 SUBMITTALS

- A. Product Data:
 1. Manufacturer's product data for routers, switches, wireless access points, controllers, licenses, optics, power supplies, and mounting accessories.
 2. Port counts, port speeds, uplink types, PoE budgets, switching capacity, forwarding performance, environmental ratings, and power requirements.
 3. Wireless radio specifications, supported frequency bands, antenna characteristics, MIMO capability, mounting options, and power requirements.
 4. Cybersecurity and management feature documentation.
 5. Warranty and support documentation.
- B. Shop Drawings:
 1. Network equipment rack elevations.
 2. Proposed switch and router locations.
 3. Wireless access point locations coordinated with reflected ceiling plans.
 4. Uplink diagrams and logical topology.
 5. Power, grounding, and UPS coordination.
 6. Patch panel-to-switch port mapping.
- C. Configuration Submittals:
 1. VLAN assignments.
 2. IP addressing plan.
 3. Routing configuration.
 4. Switch port profiles.
 5. PoE assignments.
 6. Wireless SSID configuration.
 7. Authentication and security settings.
 8. Management platform registration information.
 9. Firmware and software versions.
- D. Closeout Submittals:
 1. Final as-built network topology.

2. Device inventory with serial numbers, MAC addresses, IP addresses, firmware versions, and physical locations.
3. Final configuration files.
4. Wireless heat map or validation report, where required.
5. Test reports.
6. Warranty certificates.
7. Administrative credentials transferred to Owner in a secure manner.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 1. Network electronics shall be installed and configured by personnel trained and certified by the manufacturer or otherwise approved by Owner.
 2. Contractor shall have demonstrated experience installing enterprise network electronics in similar facilities.
- B. Manufacturer Qualifications:
 1. Manufacturer shall provide enterprise-grade routers, switches, wireless access points, management software, support services, firmware updates, and replacement parts.
 2. Manufacturer shall maintain published security update and vulnerability response processes.
- C. Regulatory Compliance:
 1. Equipment shall be listed, labeled, and approved for intended use.
 2. Wireless equipment shall comply with FCC requirements for operating frequencies and transmit power.

1.7 COORDINATION

- A. Coordinate exact locations of equipment with architectural, electrical, mechanical, ceiling, lighting, audiovisual, security, and furniture layouts.
- B. Coordinate wireless access point locations to avoid conflicts with lighting fixtures, HVAC diffusers, ceiling obstructions, metal decking, structural members, projection systems, microphones, speakers, and other systems that may affect wireless coverage.
- C. Coordinate PoE budgets with connected endpoint requirements, including wireless access points, IP phones, cameras, door controllers, intercoms, AV encoders, occupancy sensors, and other IP-connected devices.
- D. Coordinate network configuration requirements with Owner prior to installation.
- E. Do not connect active network electronics to Owner's production network without Owner approval.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver equipment in manufacturer's original packaging.
- B. Store equipment in a clean, dry, secure, temperature-controlled environment.
- C. Protect equipment from dust, moisture, static discharge, physical damage, and unauthorized access.

1.9 WARRANTY

- A. Provide manufacturers' standard warranty for network electronics, licenses, and accessories.
- B. Warranty period shall be not less than one year from the date of Substantial Completion, unless a longer period is indicated.
- C. Provide software and firmware updates during the warranty period.

PART 2 – PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

- A. Provide new, current-production network electronics.
- B. Refurbished, discontinued, gray-market, or end-of-sale equipment is not acceptable.
- C. Equipment shall be from a single manufacturer or a fully interoperable manufacturer ecosystem approved by Owner.
- D. Provide equipment quantities, port counts, optics, licenses, power supplies, mounting hardware, and accessories required for a complete operating system.
- E. Equipment shall be compatible with Owner's existing network management and cybersecurity requirements.
- F. Basis of Design:
 - 1. 27 11 16 Cabinets, Racks, Frames, and Enclosures
 - a. ProLine
 - 2. 27 11 19 Termination Blocks and Patch Panels
 - a. Iwillink
 - 3. 27 11 26 Communications Systems Power Protection (UPS)
 - a. CyberPower CP1500AVRLCD3
 - 4. 27 13 13 Copper Backbone Cabling
 - a. trueCABLE
 - 5. 27 13 23 Optical Fiber Backbone Cabling
 - a. Corning; Min. 24S from Comms Bldg to MDF/IDF
 - 6. 27 15 13 Copper Horizontal Cabling
 - a. Cat6a; trueCABLE; Black
 - 7. 27 15 23 Optical Fiber Horizontal Cabling
 - a. Corning; Yellow
 - 8. 27 16 00 Connecting Cords, Devices, and Adapters
 - a. Raplink
 - 9. 27 21 13 Routers and Switches
 - a. Extreme Switching 5420F
 - 10. 27 21 16 Wireless Access Points
 - a. Extreme AP4000-WW
 - 11. 27 21 19 Network Security Equipment
 - a. Fortinet Firewall
 - 12. 27 22 13 Servers
 - a. Dell PowerEdge R750
 - 13. 27 22 16 Storage Devices
 - a. Dell Data Storage
 - 14. 27 31 16 VOIP Systems
 - a. Mitel Connect
- G. Coordinate and confirm system design and configuration with the Owner's IT department.

2.2 ROUTERS AND GATEWAY DEVICES

- A. Provide routers suitable for WAN, LAN, campus, internet edge, security gateway, or building distribution functions as indicated.
- B. Minimum Requirements:
 - 1. Rack-mountable unless otherwise indicated.
 - 2. Support IPv4 and IPv6.
 - 3. Support static routing and dynamic routing protocols required by Owner.
 - 4. Support VLAN trunking and inter-VLAN routing.
 - 5. Support NAT, DHCP relay, ACLs, QoS, and traffic shaping where required.
 - 6. Support secure remote management using SSH and HTTPS.
 - 7. Support SNMP, syslog, NTP, and centralized monitoring.
 - 8. Provide redundant power supplies where indicated.
 - 9. Provide modular or fixed interfaces as required for project topology.
 - 10. Provide throughput capacity sufficient for connected services without oversubscription.
- C. Security Features:
 - 1. Role-based administrative access.
 - 2. Integration with Owner's authentication system where required.
 - 3. Configurable access control lists.
 - 4. Logging of configuration changes and security events.
 - 5. Support for secure firmware updates.
 - 6. Disable insecure protocols by default.
- D. WAN Interfaces:
 - 1. Provide copper, fiber, or service provider handoff interfaces as indicated.
 - 2. Provide compatible optics, transceivers, and cables.
 - 3. Coordinate demarcation requirements with Owner and service providers.

2.3 ETHERNET SWITCHES

- A. Provide managed Ethernet switches for access, distribution, core, audiovisual, security, or building systems networks as indicated.
- B. Minimum General Requirements:
 - 1. Layer 2 managed switches for access applications unless Layer 3 is indicated.
 - 2. Layer 3 switches for routing, aggregation, or distribution applications where indicated.
 - 3. Support IEEE 802.3 Ethernet operation.
 - 4. Support IEEE 802.1Q VLAN tagging.
 - 5. Support link aggregation.
 - 6. Support spanning tree or equivalent loop prevention.
 - 7. Support QoS for voice, video, AV, security, and building automation traffic.
 - 8. Support jumbo frames where required by Owner or connected systems.
 - 9. Support SNMP, syslog, NTP, SSH, HTTPS, and centralized management.
 - 10. Support firmware upgrades and configuration backup.
 - 11. Provide rack-mount hardware and cable management accessories.
- C. Access Switches:
 - 1. Provide a minimum of 48 user-facing ports per switch as indicated.
 - 2. Provide 10 Gbps copper access ports as indicated.
 - 3. Provide uplink ports of 100 Gbps as indicated.
 - 4. Provide stacking or virtual chassis capability where indicated.
 - 5. Provide a non-blocking or appropriately sized switching fabric for the intended load.

- D. Distribution/Core Switches:
 - 1. Provide a high-availability switching platform with redundant power supplies and fans.
 - 2. Provide modular or fixed uplink capacity as indicated.
 - 3. Support Layer 3 routing protocols required by Owner.
 - 4. Support redundant paths and rapid failover.
 - 5. Provide fiber optic uplinks to telecommunications rooms, equipment rooms, or campus backbone as indicated.
- E. Power over Ethernet Switches:
 - 1. Provide PoE, PoE+, or PoE++ as required by connected devices.
 - 2. Provide a total PoE power budget sufficient for all connected devices plus 20 percent spare capacity.
 - 3. Support per-port PoE monitoring and power allocation.
 - 4. Support connected wireless access points, IP phones, cameras, AV devices, and other PoE loads indicated.
 - 5. Provide redundant power or an external power shelf where required to maintain PoE during a single power supply failure.
- F. Switch Security Features:
 - 1. IEEE 802.1X support.
 - 2. MAC address limiting or port security.
 - 3. DHCP snooping where required.
 - 4. Dynamic ARP inspection where required.
 - 5. BPDU guard or equivalent loop-protection features.
 - 6. Access control lists.
 - 7. Secure management profiles.
 - 8. Disable unused ports unless otherwise directed by Owner.

2.4 WIRELESS ACCESS POINTS

- A. Provide enterprise-grade wireless access points suitable for ceiling, wall, enclosure, or exterior mounting as indicated.
- B. Wireless Standard:
 - 1. Provide access points supporting IEEE 802.11be / Wi-Fi 7, as selected by Owner.
 - 2. Access points shall support 2.4 GHz and 5 GHz operation.
 - 3. Provide 6 GHz operation where Wi-Fi 6E or Wi-Fi 7 is required and permitted by local regulations.
- C. Minimum Requirements:
 - 1. Dual-band or tri-band radios as indicated.
 - 2. Internal or external antennas as required for application.
 - 3. MIMO capability appropriate for project density and performance requirements.
 - 4. PoE-powered operation unless otherwise indicated.
 - 5. Secure wireless encryption and authentication compatible with Owner standards.
 - 6. Multiple SSIDs with VLAN mapping.
 - 7. Band steering, load balancing, and radio resource management where supported.
 - 8. Rogue AP detection or wireless intrusion detection where required.
 - 9. Centralized or cloud-based management as required by Owner.
 - 10. Plenum-rated housing where installed in environmental air plenums.
- D. Wireless Access Point Types:
 - 1. Standard indoor ceiling-mounted access point.
 - 2. High-density indoor access point for classrooms, lecture halls, auditoria, conference centers, libraries, simulation spaces, and public gathering areas.

3. Wall-mounted hospitality or dormitory-style access point where indicated.
4. Outdoor or industrial-rated access point where indicated.
5. Directional antenna or specialty access point where required by wireless design.

E. Mounting:

1. Provide manufacturer-approved mounting brackets.
2. Coordinate with ceiling type.
3. Provide surface backbox, pendant mount, wall bracket, or above-ceiling mounting kit where indicated.
4. Do not install access points above ceilings unless specifically approved by Owner and wireless design documents.
5. Install access points with unobstructed radio coverage to served area.

F. Cabling Interface:

1. Provide two Category 6A horizontal cables to each access point unless otherwise indicated.
2. Provide two cables where required by access point throughput, redundancy, or Owner standard.
3. Terminate cabling in the Communication Room (2010) patch panel and at the access point outlet or service loop as indicated.

2.5 NETWORK MANAGEMENT

A. Provide required licenses, subscriptions, controllers, virtual appliances, or cloud-management accounts for:

1. Device configuration.
2. Monitoring.
3. Firmware management.
4. Wireless radio management.
5. Client visibility.
6. Alerting and reporting.
7. Configuration backup.
8. Role-based access control.

B. License duration shall be one year, with a three-year option.

C. Register equipment to Owner's account unless otherwise directed.

D. Transfer administrative ownership to Owner prior to Substantial Completion.

2.6 ACCESSORIES

A. Provide all accessories required for complete installation, including:

1. Fiber optic transceivers.
2. Direct attach cables.
3. Stacking modules and cables.
4. Rack-mount kits.
5. Cable management hardware.
6. Patch cords.
7. Blank panels.
8. Power cords.
9. Redundant power supplies.
10. Console cables or management adapters.
11. Wireless access point brackets and security covers.
12. Labels and identification materials.

2.7 SOURCE QUALITY CONTROL

- A. Equipment shall be factory-tested prior to shipment.
- B. Provide manufacturer documentation confirming equipment compliance with specified performance, safety, and regulatory requirements.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify that telecommunications rooms, equipment racks, grounding, power, HVAC, cabling, pathways, and UPS systems are complete and suitable for installation.
- B. Verify that cabling certification has been completed before connecting network electronics.
- C. Verify that equipment room environmental conditions comply with manufacturer requirements.
- D. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install network electronics in accordance with manufacturer instructions, approved shop drawings, and Owner requirements.
- B. Install equipment plumb, level, secure, and accessible for maintenance.
- C. Install rack-mounted equipment to maintain proper airflow and service clearance.
- D. Provide cable management to avoid obstructing airflow, equipment removal, or patching access.
- E. Install power supplies, optics, stacking cables, patch cords, and accessories required for complete operation.
- F. Connect equipment to UPS-backed power where indicated.
- G. Provide grounding and bonding in accordance with Division 27 and Division 26 requirements.
- H. Do not exceed manufacturer bend radius, fill, temperature, or clearance requirements.

3.3 ROUTER INSTALLATION

- A. Install routers in designated equipment racks or cabinets.
- B. Connect WAN, LAN, management, and power interfaces as indicated.
- C. Coordinate service provider handoffs and Owner network connections.
- D. Configure routing, security, management, and monitoring parameters in coordination with the Owner.

3.4 SWITCH INSTALLATION

- A. Install switches in telecommunications rooms, equipment rooms, audiovisual racks, security racks, or other locations indicated.
- B. Install switches in logical sequence corresponding to patch panels where practical.
- C. Provide patch cords of appropriate length and color as directed by Owner.
- D. Configure switch ports according to approved port schedule.
- E. Disable unused ports unless otherwise directed by Owner.
- F. Configure PoE settings to match connected device requirements.
- G. Configure uplinks, stacking, VLANs, QoS, security, management, and monitoring features.

3.5 WIRELESS ACCESS POINT INSTALLATION

- A. Install access points at locations shown on approved wireless design drawings.
- B. Coordinate final location with ceiling grid, lighting, mechanical, audiovisual, fire protection, signage, and architectural features.
- C. Mount access points securely using manufacturer-approved hardware.
- D. Orient access points and antennas in accordance with manufacturer recommendations and wireless design.
- E. Label access points with Owner-approved identifier.
- F. Record final installed location on as-built drawings.
- G. Do not relocate access points from approved locations without Owner and Designer approval.

3.6 CONFIGURATION

- A. Configure equipment in accordance with Owner-approved configuration documents.
- B. Configuration shall include, where applicable:
 - 1. Hostnames.
 - 2. Management IP addresses.
 - 3. VLANs.
 - 4. Trunk and access ports.
 - 5. Routing.
 - 6. QoS.
 - 7. PoE.
 - 8. SSIDs.
 - 9. Wireless security.
 - 10. Authentication.
 - 11. Time synchronization.
 - 12. Logging.
 - 13. SNMP or monitoring integration.
 - 14. Firmware updates.
 - 15. Administrative access controls.
 - 16. Backup configuration.

- C. Use secure administrative protocols only.
- D. Remove default passwords and unused default accounts.
- E. Provide final credentials to Owner through a secure method approved by Owner.

3.7 FIELD QUALITY CONTROL

- A. Perform testing after installation and configuration.
- B. Test routers for:
 - 1. Interface status.
 - 2. Routing operation.
 - 3. WAN or LAN connectivity.
 - 4. Failover where applicable.
 - 5. Security policy operation.
 - 6. Management access.
 - 7. Logging and monitoring.
- C. Test switches for:
 - 1. Port operation.
 - 2. Uplink operation.
 - 3. VLAN assignment.
 - 4. PoE delivery.
 - 5. Device connectivity.
 - 6. Link speed and duplex.
 - 7. Stacking or virtual chassis operation.
 - 8. QoS operation where applicable.
 - 9. Redundant power and failover where applicable.
 - 10. Management and monitoring integration.
- D. Test wireless access points for:
 - 1. Power and network connectivity.
 - 2. Controller or cloud management registration.
 - 3. SSID broadcast.
 - 4. Authentication.
 - 5. VLAN assignment.
 - 6. Roaming.
 - 7. Coverage.
 - 8. Signal strength.
 - 9. Channel and power settings.
 - 10. Client connectivity.
 - 11. Throughput where required.
- E. Wireless Validation:
 - 1. Perform post-installation wireless survey where required.
 - 2. Validate coverage in occupied areas.
 - 3. Identify dead zones, interference, excessive co-channel interference, or access point placement issues.
 - 4. Adjust radio power and channel plan as directed by Owner.
 - 5. Submit the final wireless validation report.

3.8 SYSTEM ACCEPTANCE

- A. System acceptance requires:
 - 1. Equipment installed and operational.
 - 2. Approved firmware installed.
 - 3. Final configuration accepted by Owner.
 - 4. Successful completion of functional testing.
 - 5. Successful wireless validation where required.
 - 6. Submission of complete closeout documentation.

7. Transfer of licenses, warranties, and administrative ownership to Owner.
8. Completion of Owner training.

- B. Owner may reject equipment that is not compatible with Owner's network standards or does not meet specified performance requirements.

3.9 TRAINING

- A. Provide Owner training for installed network electronics.

- B. Training shall include:

1. System overview.
2. Equipment locations.
3. Management platform access.
4. Basic monitoring and troubleshooting.
5. Configuration backup and restore.
6. Firmware update procedures.
7. Wireless management features.
8. Warranty and support procedures.

3.10 CLOSEOUT DOCUMENTATION

- A. Submit final documentation in electronic format.

- B. Documentation shall include:

1. Final equipment inventory.
2. Final topology diagrams.
3. Rack elevations.
4. Port schedules.
5. VLAN schedules.
6. IP address schedules.
7. Wireless access point schedule.
8. Final configuration files.
9. Firmware versions.
10. License records.
11. Warranty information.
12. Test results.
13. Wireless validation report.
14. As-built drawings.

END OF SECTION 27 21 00

SECTION 27 32 23
VOICE COMMUNICATIONS ELEVATOR TELEPHONES

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
- B. Section 27 0000 – Communications General
- C. Section 27 0500 – Common Work Results for Communications
- D. Section 27 0526 – Grounding and Bonding for Communications
- E. Section 27 0528 – Pathways for Communications
- F. Section 27 0553 – Identification for Communications Systems
- G. Section 27 1116 – Communications Cabinets, Racks, Frames, and Enclosures
- H. Section 27 1119 – Communications Termination Blocks and Patch Panels
- I. Section 27 1123 – Communications Cable Management and Cable Runway
- J. Section 27 1313 – Communications Copper Backbone Cabling
- K. Section 27 1323 – Communications Optical Fiber Backbone Cabling
- L. Section 27 1513 – Communications Copper/Optical Fiber Horizontal Cabling
- M. Section 27 1543 – Communications Faceplates and Connectors

1.2 CODES AND STANDARDS

- A. Refer to Section 27 0000 – Communications General
- B. Refer to Division 1 – Reference Standards and General Conditions of the Contract

1.3 SUMMARY

- A. This Section includes Elevator Telephones

1.4 DEFINITIONS

- A. Refer to Section 27 0000 – Communications General

1.5 ACRONYMS & ABBREVIATIONS

- A. Refer to Section 27 0000 – Communications General

1.6 SUBMITTALS

- A. Refer to Section 27 0000 – Communications General
- B. Product Data Sheets
- C. Bill of Materials

1.7 MATERIALS FOR USE BY OWNER

- A. Furnish materials as described in Part 2 Products.
- B. Throughout the project lifecycle, all elevator telephones shall be securely stored at the Contractor's office facility until installed in elevators.

PART 2 – PRODUCTS

2.1 APPROVED MANUFACTURERS

- A. All IP elevator telephones approved and certified by their manufacturer to work directly with Cisco Unified Communications Manager 9.1 or above.
- B. All analog elevator telephones approved and certified by their manufacturer to work with Cisco Unified Communications Manager 9.1 or above through Cisco Systems VG350 analog to IP gateway product.

2.2 REFERENCE PART NUMBERS

- A. Refer to Section 27 0000 Communications General, Part 2 -Products
- B. The bidder shall confirm all reference part numbers listed within Division 27 as current and suitable for the items described and specified and shall file a formal RFI for all perceived discrepancies prior to bidding.
- C. All materials associated with reference parts shall be included to constitute a complete and functional system, whether or not explicitly identified, itemized, and quantified.

2.3 ELEVATOR TELEPHONE PROGRAMMING, SETUP, INSTALLATION, CONFIGURATION AND OPERATION

- A. All phases of elevator programming, setup, installation, configuration and operations must work with Cisco Unified Communications Manager 9.1 or above.
 - 1. If an IP elevator phone is provided, it must work on standard Ethernet cabling with Power over Ethernet, directly connecting over the Owner's network with Cisco Unified Communications Manager 9.1 or above.
 - 2. If an analog elevator phone is provided, it must work with Cisco Unified Communications Manager 9.1 or above and connect through Cisco's VG350 analog to the IP gateway product.

PART 3 – EXECUTION

- 3.1 The Contractor shall provide all elevator phones.
- 3.2 The Contractor shall install all elevator phones.
- 3.3 The Contractor shall do all programming, setup, and configuration needed to make the elevator

phones fully functional and operating in the Owner's environment.

- 3.4 The Owner will provide elevator telephone numbers.
- 3.5 The Owner will do all programming or settings the Contractor requests on Cisco Communications Manager or analog gateways.
- 3.6 The Contractor will make all programming or settings changes on elevator phones.

END OF SECTION 27 32 23

SECTION 27 51 16
VOICE OVER INTERNET PROTOCOL (VOIP) TELEPHONE SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Voice over Internet Protocol (VoIP) telephone system infrastructure.
 2. IP telephones and endpoint devices.
 3. PoE-powered VoIP devices.
 4. SIP-based communications equipment.
 5. Integration with the Owner's existing campus Mitel communications platform.
 6. Voice VLAN implementation coordination.
 7. Network connectivity requirements.
 8. E911 and emergency notification integration.
 9. Telephone station cabling coordination.
 10. Testing, commissioning, and training.
- B. Related Sections:
1. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
 2. Section 27 05 26 – Grounding and Bonding for Communications Systems.
 3. Section 27 05 28 – Pathways for Communications Systems.
 4. Section 27 10 00 – Structured Cabling Systems.
 5. Section 27 21 00 – Data Communications Network Equipment.
 6. Section 28 46 00 – Emergency Communications Systems.

1.2 REFERENCES

- A. Comply with the latest adopted editions of:
1. ANSI/TIA-568 – Telecommunications Cabling Standards.
 2. ANSI/TIA-569 – Telecommunications Pathways and Spaces.
 3. ANSI/TIA-606 – Administration Standard.
 4. ANSI/TIA-607 – Grounding and Bonding Requirements.
 5. IEEE 802.3af/at/bt – Power over Ethernet Standards.
 6. NFPA 70 – National Electrical Code.
 7. UL 60950 and UL 62368.
 8. FCC Part 15.
 9. BICSI Telecommunications Distribution Methods Manual (TDMM).

1.3 SYSTEM DESCRIPTION

- A. Provide complete VoIP telecommunications systems for new campus building integrated with Owner's existing enterprise Mitel communications environment.
- B. System shall utilize Owner's existing:
1. Campus IP network backbone.
 2. Existing Mitel call management servers.
 3. Existing SIP trunking services.
 4. Existing voicemail/unified communications infrastructure.
 5. Existing E911 management platform.
- C. Building system shall support:
1. Voice communications.
 2. Unified communications applications.

3. Softphone connectivity.
4. SIP endpoint registration.
5. Power over Ethernet (PoE) endpoint powering.
6. Voice VLAN segregation.
7. QoS prioritization.
8. Emergency calling services.

- D. System architecture shall support future migration and expansion without replacement of installed infrastructure.

1.4 SUBMITTALS

A. Product Data:

1. Mitel endpoint devices.
2. PoE requirements.
3. Network switch compatibility.
4. SIP compatibility documentation.
5. Licensing requirements.
6. Rack mounting requirements.

B. Shop Drawings:

1. System riser diagrams.
2. Voice VLAN topology.
3. Equipment rack elevations.
4. Patching diagrams.
5. Telecommunications room layouts.
6. Endpoint schedules.
7. Cable labeling schedules.

C. Coordination Drawings:

1. Coordination with structured cabling.
2. Coordination with Owner network services.
3. UPS power coordination.
4. Coordination with wireless systems if Wi-Fi calling utilized.

D. Closeout Submittals:

1. As-built drawings.
2. MAC address inventory.
3. IP addressing documentation.
4. Endpoint inventory.
5. Programming backup files.
6. Warranty documentation.
7. Training materials.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Minimum five years of documented experience installing enterprise VoIP systems.
2. Certified Mitel business partner or authorized installer.
3. Personnel trained on Mitel platform integration.

B. System Integrator Qualifications:

1. Experience integrating with higher education campus telecommunications systems.
2. Experience coordinating with enterprise IT departments.
3. Experience implementing QoS-enabled VoIP systems.

1.6 COORDINATION

- A. Coordinate with Owner's IT department for:
 - 1. IP addressing.
 - 2. VLAN assignments.
 - 3. DHCP scopes.
 - 4. QoS configuration.
 - 5. Network switch provisioning.
 - 6. SIP registration.
 - 7. E911 location mapping.
- B. Coordinate all shutdowns and cutovers with Owner.
- C. Coordinate all MDF/IDF rack space requirements.

1.7 WARRANTY

- A. Provide a one-year minimum system warranty, including:
 - 1. Parts.
 - 2. Labor.
 - 3. Software updates.
 - 4. Firmware updates.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design:
 - 1. Mitel
- B. Subject to compliance with requirements, provide Mitel products compatible with the Owner's existing enterprise communications environment.

2.2 VOIP SYSTEM REQUIREMENTS

- A. System shall support:
 - 1. SIP-based communications.
 - 2. IEEE-compliant PoE endpoints.
 - 3. DHCP provisioning.
 - 4. LLDP-MED.
 - 5. VLAN tagging.
 - 6. QoS prioritization.
 - 7. G.711 and G.729 codecs.
 - 8. Full duplex speakerphone operation.
 - 9. Gigabit Ethernet pass-through ports at desktop phones.
- B. System shall support centralized management from the Owner's existing Mitel management environment.

2.3 IP TELEPHONES

- A. General Requirements:
 - 1. Enterprise-grade SIP-compatible IP telephones.
 - 2. Color display where indicated.
 - 3. HD voice support.

4. Integrated Gigabit switch.
5. PoE powered.
6. Hearing-aid compatible.
7. Wall-mount capable where indicated.

B. Acceptable Products:

1. Mitel 6900 Series IP Phones.
2. Mitel 6905.
3. Mitel 6910.
4. Mitel 6920.
5. Mitel 6930.
6. Mitel 6940.

C. Features:

1. Programmable soft keys.
2. Presence indication.
3. Voicemail indication.
4. Headset support.
5. Speakerphone.
6. Directory integration.

2.4 CONFERENCE PHONES

A. Conference room endpoints shall include:

1. SIP-compatible conference phones.
2. Echo cancellation.
3. Omni-directional microphones.
4. PoE operation where possible.

B. Basis of Design:

1. Mitel Conference Unit.
2. Approved interoperable SIP conference endpoint.

2.5 POWER OVER ETHERNET

A. Endpoint devices shall be powered using IEEE 802.3af/at compliant PoE switches.

B. Coordinate PoE budget with Section 27 21 00.

C. Provide UPS-backed network switch infrastructure supporting voice services.

2.6 NETWORK REQUIREMENTS

A. Owner shall provide campus backbone connectivity.

B. Contractor shall coordinate:

1. Voice VLAN configuration.
2. QoS policies.
3. DSCP prioritization.
4. DHCP options.
5. LLDP-MED configuration.

C. Voice traffic shall receive priority over general data traffic.

2.7 TELECOMMUNICATIONS CABLING

- A. Horizontal cabling shall be specified under Section 27 10 00.
- B. Provide minimum:
 - 1. One Category 6A cable to each VoIP telephone outlet unless otherwise indicated.
 - 2. Additional cabling for attendant consoles or specialty devices.
- C. Telecommunications outlets shall be labeled in accordance with ANSI/TIA-606.

2.8 RACK-MOUNTED EQUIPMENT

- A. Provide:
 - 1. Patch panels.
 - 2. Cable management.
 - 3. Horizontal and vertical wire managers.
 - 4. Rack grounding.
 - 5. Labeling.
- B. Coordinate with telecommunications room layouts.

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Verify:
 - 1. Telecommunications rooms are complete.
 - 2. Power systems are operational.
 - 3. Network infrastructure is available.
 - 4. Environmental systems are operational.

3.2 INSTALLATION

- A. Install in accordance with:
 - 1. Manufacturer recommendations.
 - 2. ANSI/TIA standards.
 - 3. BICSI best practices.
- B. Maintain separation from power conductors per NEC and TIA requirements.
- C. Provide neat and professional installation.

3.3 CONFIGURATION

- A. Coordinate programming with Owner.
- B. Configure:
 - 1. SIP registration.
 - 2. VLAN tagging.
 - 3. Extension assignments.
 - 4. Emergency dialing.
 - 5. Caller ID.
 - 6. Voicemail integration.
 - 7. Directory services.

3.4 E911 REQUIREMENTS

- A. Configure all endpoints for compliant E911 location reporting.
- B. Coordinate with Owner's emergency notification systems.
- C. Verify:
 - 1. Correct location mapping.
 - 2. Building identifiers.
 - 3. Room-level location information where required.

3.5 TESTING

- A. Perform:
 - 1. Endpoint registration testing.
 - 2. Call routing testing.
 - 3. QoS verification.
 - 4. E911 testing.
 - 5. Voicemail testing.
 - 6. Network failover testing.
 - 7. PoE load testing.

- B. Demonstrate system operation to Owner.

3.6 TRAINING

- A. Provide a minimum of four hours of onsite training for Owner staff, including:
 - 1. Endpoint operation.
 - 2. Administrative functions.
 - 3. Basic troubleshooting.
 - 4. Moves/adds/changes procedures.

3.7 CLOSEOUT

- A. Provide:
 - 1. Final programming files.
 - 2. IP inventory.
 - 3. MAC address inventory.
 - 4. As-built documentation.
 - 5. Test reports.
 - 6. Warranty certificates.

END OF SECTION 27 51 16

SECTION 28 00 00
ELECTRONIC SAFETY & SECURITY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Design, supply, installation, programming, and testing of the project's electronic safety and security systems compatible with the Owner's existing district-wide systems.
2. Systems covered include access control, video surveillance, fire alarm integration, and system monitoring.

B. Related Sections:

1. Section 260000 – Electrical: Power supply and infrastructure requirements for security systems.

1.2 REFERENCES

A. Standards Compliance:

1. National Electrical Code (NEC).
2. Underwriters Laboratories (UL) Standards:
 - a. UL 294 – Access Control System Units.
 - b. UL 639 – Intrusion Detection Units.
 - c. UL 1076 – Proprietary Burglar Alarm Units and Systems.
3. American National Standards Institute (ANSI) / Security Industry Association (SIA) Standards.
4. National Fire Protection Association (NFPA) 72 – Fire Alarm and Signaling Code.
5. Building Industry Consulting Service International (BICSI) – Information Transport Systems Installation Methods Manual.

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer's technical product data sheets for all components, including access control panels, cameras, intrusion sensors, and networking devices.
2. Detailed descriptions of system capabilities, capacities, and power requirements.

B. Shop Drawings:

1. System layout showing component locations, wiring, and system interconnectivity.
2. Network diagrams showing communication paths between devices, control panels, and monitoring stations.

C. Closeout Submittals:

1. As-built drawings showing the final layout of all installed systems and components.
2. Operation and maintenance manuals, warranty documents, and system programming/configuration details.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. The Contractor must carry out the installation and have at least five years of experience installing electronic safety and security systems of similar size and complexity.
- B. Technicians must be certified by the system manufacturers to install and maintain all specified equipment.
- C. Installer Qualifications
 - 1. Minimum 5 years' experience installing access control and IP video systems of similar scale.
 - 2. Certified integrator partner of at least one of the following:
 - a. Access Control
 - i. LenelS2 OnGuard
 - ii. Gallagher Command Centre
 - iii. HID Global (Assa Abloy)
 - b. Video Surveillance
 - i. Axis Communications
 - ii. Bosch Security Systems
 - iii. Hanwha Vision
- B. Manufacturer Qualifications:
 - 1. The manufacturer must have at least ten years of experience producing UL-listed safety and security equipment.

1.5 ACCESS CONTROL SYSTEM DESCRIPTION

- A. The Access Control System shall provide:
 - 1. Door monitoring and control.
 - 2. Credential management and cardholder database.
 - 3. Alarm monitoring and event reporting.
 - 4. Scheduled automatic unlocks for public Library areas.
 - 5. Integration with VSS to link alarms with video.
- B. System Requirements
 - 1. Support HID iCLASS SE or SEOS smart credentials.
 - 2. Support PoE or PoE+ powered door controllers where possible.
 - 3. Peer-to-peer controller operation during network outages.
- C. Access Control Hardware
 - 1. Door Controllers
 - a. UL 294 listed.
 - b. Local database fallback.
 - c. On-board PoE powering where available.
 - 2. Reader Interfaces
 - a. HBUS readers or HID interface modules.

3. Card Readers
 - a. Mullion and wall-mount reader options.
 - i. Compatible with HID iCLASS SE/SEOS or MIFARE DESFire EV3.
 - ii. Weather-rated for exterior readers (IP65 minimum).
4. Door Position Switches
 - a. Recessed magnetic type, SPDT.
5. Request-to-Exit Devices
 - a. Motion sensor REX plus emergency push button.
6. Electrified Door Hardware
 - a. Electrified strikes, panic devices, or maglocks as scheduled under Division 08.
 - b. Provide power supplies with battery backup where PoE is not used.

1.6 VIDEO SURVEILLANCE SYSTEM

- A. The Video Surveillance System shall provide:
 1. Continuous recording for a minimum of 30 days retention.
 2. ONVIF Profile S, G, and T compatibility.
 3. Centralized video management (VMS).
 4. Motion detection, analytics, and event-based recording.
- B. Video Surveillance Cameras
 1. Resolution 4 MP minimum (8 MP for exterior where required).
 2. PoE or PoE+ powered.
 3. True WDR, low-light optimization.
 4. IEC 62471 and NDAA compliant.
- C. Video Surveillance Camera Types (as shown on drawings)
 1. Fixed Dome Cameras
 2. Fixed Bullet Cameras
 3. PTZ Cameras
 4. Multi-Sensor Cameras
- D. Video Management System
 1. VMS Options
 - a. Camera Manufacturer Video Management System
 - b. Open-platform VMS such as Milestone or Genetec (Confirm with Owner)
 2. VMS Requirements
 - a. Searchable event logs tied to access control events.
 - b. Multi-client access with user rights management.
 - c. Export in MP4 and secure authentication.
 - d. Integration with ACS via API or ONVIF events.
- E. Network Video Recorders / Storage
 1. Network Video Recorder
 - a. Enterprise-grade network servers with RAID 5/6.
 - b. Hot-swap HDDs.
 - c. Throughput sized for retention calculations.
 2. Storage Requirements
 - a. Calculate storage based on:
 - i. 15–20 FPS
 - ii. H.265 encoding
 - iii. 30 days retention
 - b. Provide 20% overhead for future expansion.
- F. Cabling And Wiring
 1. All cabling provided under Division 27 unless otherwise noted.

2. Minimum CAT6 for cameras and door controllers.
3. Provide plenum-rated cabling in air plenums.
4. Grounding and bonding per NEC.

2.4 POWER REQUIREMENTS

- A. Provide UPS backup for all ACS and VSS head-end equipment.
- B. Door power supplies shall include battery backup for 4 hours minimum if not PoE-powered.

2.5 WARRANTY

- A. Provide a two-year warranty covering all system components and labor.

PART 2 - PRODUCTS

2.1 GENERAL SYSTEM REQUIREMENTS

- A. System Components:
 1. All safety and security systems shall be integrated, scalable, and capable of continuously monitoring and controlling the building's security functions.
 2. Systems shall include access control, video surveillance, and fire alarm interface.
 3. The system shall allow for remote monitoring and management via secure web or mobile applications.
- B. Integration Requirements:
 1. Systems shall integrate seamlessly with the Owner's existing electronic security monitoring management system, allowing for unified control of security systems.
 2. Integration with third-party systems, including fire alarms and emergency notification systems, is required.

2.2 ACCESS CONTROL SYSTEM

- A. Access control system shall include the following components:
 1. Access control panels, proximity card readers, and biometric readers.
 2. Electric door locks, magnetic locks, and electronic strikes.
 3. System software with real-time access management, scheduling, and reporting capabilities.
 4. Power over Ethernet (PoE) switches for device connections and control.
- B. Features:
 1. Support for time zones, access groups, and individual user privileges.
 2. Event logging and real-time alerts for unauthorized access or system tampering.
 3. Integration with video surveillance systems for event-triggered video recording.

C. Basis of Design Manufacturers – Confirm with Owner

1. LenelS2 OnGuard
2. Gallagher Command Centre
3. HID Global (Assa Abloy)

2.3 VIDEO SURVEILLANCE SYSTEM

A. Surveillance system components:

1. IP-based cameras (fixed, PTZ, and specialty cameras) with a minimum resolution of 1080p.
2. Network Video Recorders (NVR) with RAID storage and at least 30 days of footage retention.
3. Video management software (VMS) is capable of event-driven recording and live streaming.

B. Features:

1. Motion detection, tamper alerts, and automatic tracking for PTZ cameras.
2. Integration with access control and intrusion detection systems for event correlation.
3. Remote access via encrypted connections for off-site viewing.

C. Basis of Design Manufacturers – Confirm with Owner

1. Hanwha Vision
2. Axis Communications
3. Bosch Security Systems

2.4 FIRE ALARM SYSTEM INTEGRATION

A. The electronic safety and security system shall integrate with the building's fire alarm system for coordinated response to fire events.

1. The system shall deactivate access control locks and automatically release fail-safe door locks during fire events.
2. The video surveillance system shall record video footage triggered by fire alarms to assist in post-incident review.

2.6 CABLING AND CONNECTIVITY

A. Cabling:

1. Use Category 6a (Cat6a) Ethernet cabling for all networked devices, ensuring proper shielding and adherence to local building codes.
2. Fiber optic cabling for backbone connections where distances exceed 300 feet.
3. Plenum-rated cables shall be used in air-handling spaces.

B. Power Supplies:

1. Provide Power over Ethernet (PoE) switches for security devices.
2. Battery backup units for control panels, cameras, and recording equipment with at least 8 hours of operational capacity during a power failure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install all system components per manufacturer's guidelines, local building codes, and NEC requirements.
2. Coordinate with other trades to ensure proper integration of security systems with electrical, fire, and building management systems.

B. Device Installation:

1. Mount all security cameras at heights and angles, ensuring complete coverage of critical areas.
2. Install access control devices at doorways, ensuring alignment of magnetic contacts and secure placement of biometric readers.
3. To avoid false alarms, place intrusion detection devices, including motion sensors and glass break detectors, in strategic locations.

C. Cabling Installation:

1. All cabling shall be installed in conduits or raceways where required and labeled at both ends for identification.
2. Test all cabling for continuity and compliance with network standards before connecting to system components.

3.2 SYSTEM PROGRAMMING AND CONFIGURATION

A. System Programming:

1. Program access control panels, video management software, and intrusion detection systems according to the building's security protocol.
2. Establish user roles, access privileges, and schedules for controlled access areas.
3. Configure event triggers for video surveillance and intrusion detection, ensuring alarms are tied to specific security events.

B. Integration Testing:

1. Test system integration with access control, video surveillance, intrusion detection, and fire alarm systems.
2. Simulate security events to verify alarm notifications, recording initiation, and system logging functions.

3.3 TESTING AND COMMISSIONING

A. System Testing:

1. Test each security component, including cameras, access control devices, intrusion detection sensors, and alarm systems, for proper operation.
2. Test system response to alarms, including automatic alerts to the central monitoring station and security personnel.

- B. Commissioning:
 - 1. After successful testing, commission the system for full operation and turnover to the building's security personnel.
 - 2. Provide detailed training to staff on system operation, monitoring, and basic troubleshooting procedures.

3.4 CLOSEOUT AND DOCUMENTATION

- A. Provide the building owner with as-built drawings, operation manuals, and programming documentation.
- B. Provide a recommended maintenance schedule, including battery replacement and system software updates.
- C. Ensure all warranties and closeout documents are submitted before final handover.

END OF SECTION 28 00 00

SECTION 28 31 11
ADDRESSABLE FIRE ALARM SYSTEM

1. GENERAL

1.1 SUMMARY

- A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.
- B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.
- C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:
 - 1. Fire alarm and detection operations
 - 2. Control and monitoring of elevators, smoke control equipment, door hold-open devices, fire suppression systems, and other equipment as indicated in the drawings and specifications.
 - 3. One-way supervised automatic voice alarm operations.

1.2 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with requirements, provide alternate products by one of the following:
 - 1. Notifier
 - 2. Honeywell
 - 3. Siemens Fire Technology
- B. The Manufacturer shall be a nationally recognized company specializing in fire alarm and detection systems. This organization shall employ factory trained and NICET certified technicians, and shall maintain a service organization within 100 miles of this project location. The Manufacturer and service organization shall have a minimum of 10 years experience in the fire protective signaling systems industry.
- C. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.

1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.
- B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:
 - 1. Division 26: "Basic Electrical Materials and Methods."
 - 2. Division 26: "Wiring Methods."
- C. The system and all associated operations shall be in accordance with the following:
 - 1. Guidelines of the following Building Code: IBC
 - 2. IFC

3. NFPA 72, National Fire Alarm Code
4. NFPA 70, National Electrical Code
5. NFPA 101, Life Safety Code
6. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems
7. Other applicable NFPA standards
8. Local Jurisdictional Adopted Codes and Standards
9. ADA Accessibility Guidelines

D. Seismic Requirements:

1. **Reference Section 23 05 48 "Seismic and Vibration Isolation Controls for HVAC, Plumbing, and Electrical Building Systems." for seismic restraint devices and installation.**
2. **Seismic Performance: All Fire Alarm system components and all supporting services are to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7.**
 - a. **The term "withstand" means the system components will remain in place without separation of any parts when subjected to the seismic forces specified. System shall be capable of continued operation after the seismic event.**
3. **"Component Importance Factor" (as defined in ASCE/SEI 7) pertinent to the following specification section:**
 - a. **Fire Alarm System: $I_p = 1.5$.**

1.4 SYSTEM DESCRIPTION

- A. General: Provide a complete, non-coded, addressable, microprocessor-based, **horn-based** fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.
- B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download.
- C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.
- D. Recording of Events: During installation and testing record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications
- E. Wiring/Signal Transmission:
 1. Transmission shall be hard-wired, using separate individual circuits for addressable signal transmission, dedicated to fire alarm service only].

2. System connections for initiating SLC circuits and notification appliance circuits.
3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

F. Remote Access:

1. FACP shall be capable of providing Remote Access through a network connection (without additional software or hardware) using the public switched telephone system of a private switched telephone system.
2. A personal computer or technician's laptop, configured with terminal emulation software shall have the ability to access the FACP for diagnostics, maintenance reporting and information gathering.
3. FACP shall be capable of providing Remote Access (without additional software or hardware) through a listed Internet Interface via a standard web browser user interface.

G. 24 Hour Monitoring:

1. System shall annunciate all signals as required by NFPA 72 and NFPA 101 to a 24-hour central monitoring location. System shall be capable of providing necessary signal via IP, POTS, and/or cellular. Exact requirements shall be coordinated with Owner. Fire Alarm manufacturer is responsible for ensuring all equipment is provided so as to be compatible with the Owner's 24 hour central monitoring location/company.

H. Required Functions: The following are required system functions and operating features:

1. Priority of Signals: alarm have the highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
2. Noninterfering: An event on one zone does not prevent the receipt of signals from any other zone. All zones are manually resettable from the FACP after the initiating device or devices are restored to normal. The activation of an addressable device does not prevent the receipt of signals from subsequent activations.
3. Automatically route alarm, supervisory, and trouble signals to an Owner designated location (remote central station).
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP, indicating the location and type of device.
5. General Alarm: A system general alarm shall include:
 - a. Indication of alarm condition at the FACP.
 - b. Identification of the device that is the source of the alarm at the FACP.
 - c. Operation of audible and visible notification devices throughout the building until silenced at FACP.
 - d. Closing doors normally held open by magnetic door holders.
 - e. Unlocking designated doors.
 - f. Shutting down building supply and return fans when alarm is initiated.
 - g. Closing smoke dampers in building when alarm is initiated.
 - h. Notifying the local fire department.
6. Supervisory Operations: Upon activation of a supervisory device the system shall operate as follows:

- a. Activate the system supervisory service audible signal and illuminate the LED at the control unit.
 - b. Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
 - c. Record the event in the FACP historical log.
 - d. Transmission of supervisory signal to an Owner designated remote central station.
 - e. Restoring the condition shall cause the Supervisory LED to clear and restore the system to normal.
- 7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible alarm signals shall cease operation while strobes continue to alarm.
- 8. System Reset
 - a. The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-arming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
 - b. Should an alarm condition continue, the system will remain in an alarmed state.
- 9. A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
- 10. WALKTEST: The system shall have the capacity of 8 programmable pass-code protected one person testing groups, such that only a portion of the system need be disabled during testing. The actuation of the "enable one person test" program at the control unit shall activate the "One Person Testing" mode of the system as follows:
 - a. The city circuit connection shall be bypassed for the testing group.
 - b. Control relay functions associated to one of the 8 testing groups shall be bypassed.
 - c. The control unit shall indicate a trouble condition.
 - d. The alarm activation of any initiation device in the testing group shall cause the audible notification appliances to sound to identify the device or zone.
 - e. The unit shall automatically reset itself after signaling is complete.
 - f. Any momentary opening of initiating or notification appliance circuit wiring shall cause the audible signals to voice announce the trouble condition.
- I. Analog Smoke Sensors:
 - 1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
 - 2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
 - 3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
 - 4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a video display or printed for annual recording and logging of the calibration maintenance schedule.
 - 5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to indicate that a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate that a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This

condition provides a means to alert maintenance staff of a dirty sensor without creating a trouble in the system. If this indicator is ignored, a second level "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Central Monitoring Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.

6. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.
7. Programmable bases. It shall be possible to program relay and sounder bases to operate independently of their associated sensor.
8. Magnet test activation of smoke sensors shall be distinguished by its label and history log entry as being activated by a magnet.

J. Smoke Detectors: A maintenance and testing service providing the following shall be included with the base bid:

1. Biannual sensitivity reading and logging for each smoke sensor.
2. Scheduled biannual threshold adjustments to maintain proper sensitivity for each smoke sensor.
3. Threshold adjustment to any smoke sensor that has alarmed the system without the presence of particles of combustion.
4. Scheduled biannual cleaning or replacement of each smoke detector or sensor within the system.
5. Semi-annual functional testing of each smoke detector or sensor using the manufacturer's calibrated test tool.
6. Written documentation of all testing, cleaning, replacing, threshold adjustment, and sensitivity reading for each smoke detector or sensor device within the system.
7. The initial service included in the bid price shall provide the above listed procedures for a period of five years after owner acceptance of the system.

K. Audible Alarm Notification: By tone signals on horns in areas as indicated on drawings.

L. Visual Alarm Notification: By xenon flash tube signal on fire alarm strobe devices in areas as indicated on drawings.

M. Fire Suppression Monitoring:

1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
2. Sprinkler/Stand Pipe valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.
3. WSO: Water flow switch and sprinkler/stand pipe valve tamper switch shall be capable of existing on the same initiating zone. Activation of either device shall distinctly report which device is in alarm on the initiating zone.

N. Power Requirements

1. The control unit shall receive AC power via a dedicated branch circuit.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in accordance with code requirements. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.

4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
5. The system batteries shall be supervised so that a low battery or depleted battery condition or disconnection of the battery shall be indicated at the control unit and displayed for the specific fault type.
6. The system shall support NAC Lockout feature to prevent subsequent activation of Notification Appliance Circuits after a Depleted Battery condition occurs in order to make use of battery reserve for front panel annunciation and control
7. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary (AC) and secondary (battery) power conditions.
8. All notification circuits shall have a minimum of 20% spare current draw capacity for future devices. At a minimum, each floor shall be on its own circuit. Provide additional circuits per floor as required to accommodate actual number of devices shown on plan.
9. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.5 SUBMITTALS

- A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
 1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
 2. Wiring diagrams from manufacturer.
 3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of annunciator. All notification circuits shall have a minimum of 20% spare current draw capacity for future devices.
 4. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
 5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of IDC, NAC, relay, sensor, and auxiliary control circuits.
 6. Operating instructions for FACP.
 7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
 8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.
 9. Record of field tests of system.
- B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

- B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.7 MAINTENANCE SERVICE

- A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.
- B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.
- C. Additional Services: Perform services within the above 12-month period not classified as routine maintenance or as warranty work when authorized in writing. Compensation for additional services must be agreed upon in writing prior to performing services.
- D. Renewal of Maintenance Service Contract: No later than 60 days prior to the expiration of the maintenance services contract, deliver to the Owner a proposal to provide contract maintenance and repair services for an additional one-year term. Owner will be under no obligation to accept maintenance service contract renewal proposal.

1.8 EXTRA MATERIALS

- A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:
 - 1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
 - 2. Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
 - 3. Smoke Detectors or Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
 - 4. Detector or Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.

2. PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP)

- A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."
- B. The following FACP hardware shall be provided:
 - 1. Power Limited base panel with red cabinet and door, 120 VAC input power.
 - 2. Point capacity equal to a minimum of 150% of the points required by the plans, where (1) point equals (1) monitor (input) or (1) control (output).
 - 3. Point capacity equal to a minimum of 150% of points required by the plans, of Network Annunciation at FACP Display when applied as a Network Node
 - 4. Point capacity equal to a minimum of 150% of points required by the plans, of annunciation where one (1) point of annunciation equals:

- a. 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
 - b. 1 LED on panel or 1 switch on panel.
- 5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FCP LCD Display.
- 6. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form "C" contact output.
- 7. One Auxiliary electronically re-settable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
- 8. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
- 9. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
- 10. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
- 11. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
- 12. The FACP shall support (4) RS-232-C ports and one service port.
- 13. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
- 14. Programmable DACT for Point Reporting.
- 15. Service Port Modem for dial in pass-code access to all fire control panel information.
- C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.
- D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.
- E. Distributed Module Operation: FACP shall be capable of allowing remote location of the following modules; interface of such modules shall be through a Style 4 (Class B) supervised serial communications channel (SLC):
 - 1. Addressable Signaling Line Circuits
 - 2. Initiating Device Circuits
 - 3. Notification Appliance Circuits
 - 4. Auxiliary Control Circuits
 - 5. Annunciator LED/Switch Control Modules

2.2 REMOTE LCD ANNUNCIATOR

- A. Provide a remote LCD annunciator with the same "look and feel" as the FACP operator interface. The remote LCD annunciator shall use the same Primary Acknowledge, Silence and Reset Keys, Status LEDs and LCD Display as the FACP.
- B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with four (4) programmable control switches and associated LEDs.

- C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.
- D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.
- E. The LCD shall display the following information relative to abnormal condition of a point in the system:
 - 1. 40 character custom location label.
 - 2. Type of device (e.g. smoke, pullstation, water flow).
 - 3. Point status (e.g., alarm, trouble).
- F. Operator keys shall be key switch enabled to prevent unauthorized use. They key shall only be removable in the disabled position.
- G. Acknowledge, Silence and Reset operations shall be the same as the FACP

2.3 REMOTE PC ANNUNCIATOR

- A. Fire Alarm Control Unit shall be capable of operating remote monitors and/or printers; output shall be ASCII from an RS-232-C connection with an adjustable baud rate.
- B. Fire Alarm Control Unit shall be capable, without the additional of hardware or software, of operating a PC Annunciator which provides status annunciation and limited system control using a convenient and familiar Microsoft Windows® operating system based interface. PC Annunciator shall provide the following functions:
 - 1. Login/logout password protection with time duration selectable automatic logout
 - 2. Displays Alarm, Supervisory, Priority 2, and Trouble conditions with numerical tallies for each
 - 3. Displays first and last alarms
 - 4. Different event types have separate visible indicators with a common audible indicator
 - 5. Event logs can be searched and printed
 - 6. View and/or print status reports and service reports (printing requires an available local or network printer)
 - 7. Alarm Silence; System Reset; and Priority 2 Reset
 - 8. Global and individual point acknowledge
 - 9. Set system time and date; and clear event log
 - 10. Individual point access for control or parameter revisions
- C. Each RS-232-C port shall be capable of supporting and supervising a remote Printer; the FACP shall support as many as two (2) remote displays. The Fire Alarm Control Panel shall support five (5) RS-232-C ports.

2.4 EMERGENCY POWER SUPPLY

- A. General: Components include battery, charger, and an automatic transfer switch.
- B. Battery: Sealed lead-acid. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of time in accordance with code requirements and as follows:

1. Batteries must be capable of operating the system in normal mode for 24 hours with sufficient capacity to operate the panel in alarm mode for 15 minutes at the end of that 24 hour period.

C. Battery size shall be a minimum of 125% of the calculated size.

2.5 ADDRESSABLE MANUAL PULL STATIONS

- A. Description: Addressable single-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.
- B. Protective Shield: Provide a tamperproof, clear LEXAN shield and red frame that easily fits over manual pull stations. When shield is lifted to gain access to the station, a battery powered piercing warning horn shall be activated. The horn shall be silenced by lowering and realigning the shield. The horn shall provide 85dB at 10 feet and shall be powered by a 9 VDC battery.

2.6 ADDRESSABLE SMOKE SENSORS

- A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:
 1. Factory Nameplate: Serial number and type identification.
 2. Operating Voltage: 24 VDC, nominal.
 3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
 4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the detector head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
 5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit. In alarm condition, the sensor base LED shall be on steady.
 6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
 7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
 8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
 9. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP.
- B. Type: Smoke sensors shall be of the photoelectric or combination photoelectric / heat type. Where acceptable per manufacturer specifications, ionization type sensors may be used.
- C. Bases: Relay output, sounder and isolator bases shall be supported alternatives to the standard base.
- D. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. In ducts with air-duct velocities lower than 100 feet per minute (transfer ducts, large air plenums, etc.) the detector shall have an air-duct velocity range of 0-3000 feet per minute.

Coordinate all air velocity ranges with the Division 23 Contractor. Sensor includes relay as required for fan shutdown.

1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct sensor shall be provided by the FACP.
2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.
3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Housing shall provide a magnetic test area and Red sensor status LED.
7. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
8. Each duct sensor shall have a Remote Test Station with an alarm LED and test switch.
9. Where indicated a NEMA 4X weatherproof duct housing enclosure shall provide for the circulation of conditioned air around the internally mounted addressable duct sensor housing to maintain the sensor housing at its rated temperature range. The housing shall be UL Listed to Standard 268A.
10. Detector shall have dry contacts for connection to BMS system.

2.7 ADDRESSABLE HEAT SENSORS

- A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.
- B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.
- C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.
- D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.8 ADDRESSABLE CIRCUIT INTERFACE MODULES

- A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.
- B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required. The two-wire signaling line circuit shall supply power and communications to the module.
- C. There shall be the following types of modules:

1. Type 1: Monitor Circuit Interface Module:
 - a. For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. The supervision of the zone wiring will be Class B. This module will communicate status (normal, alarm, trouble) to the FACP.
 - b. For conventional 4-wire smoke detector with Class B wiring supervision. The module will provide detector reset capability and over-current power protection for the 4-wire detector. This module will communicate status (normal, alarm, trouble) to the FACP.
2. Type 2: Monitor Circuit Interface Module
 - a. This type of module is an individually addressable module that has both its power and its communications supplied by the two wire multiplexing signaling line circuit. It provides location specific addressability to an initiating device by monitoring normally open dry contacts. This module shall have the capability of communicating four zone status conditions (normal, alarm, current limited, trouble) to the FACP.
 - b. This module shall provide location specific addressability for up to five initiating devices by monitoring normally closed or normally open dry contact security devices. The module shall communicate four zone status conditions (open, normal, abnormal, and short).
3. Type 3: Single Address Multi-Point Interface Modules
 - a. This multipoint module shall provide location specific addressability for four initiating circuits and control two output relays from a single address. Inputs shall provide supervised monitoring of normally open, dry contacts and be capable of communicating four zone status conditions (normal, open, current limited, and short). The input circuits and output relay operation shall be controlled independently and disabled separately.
 - b. This dual point module shall provide a supervised multi-state input and a relay output, using a single address. The input shall provide supervised monitoring of two normally open, dry contacts with a single point and be capable of communicating four zone status conditions (normal, open, current limited, and short). The two-wire signaling line circuit shall supply power and communications to the module.
 - c. This dual point module shall monitor an unsupervised normally open, dry contact with one point and control an output relay with the other point, using a single address. The two-wire signaling line circuit shall supply power and communications to the module.
4. Type 4: Control Circuit Interface Module
 - a. This module shall provide control and status tracking of a Form "C" contact. The two-wire signaling line circuit shall supply power and communications to the module.
5. Type 5: 4-20 mA Analog Monitor Circuit Interface Module
 - a. This module shall communicate the status of a compatible 4-20 mA sensor to the FACP. The FACP shall annunciate up to three threshold levels, each with custom action message; display and archive actual sensor analog levels; and permit sensor calibration date recording.

- D. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.9 MAGNETIC DOOR HOLDERS

- A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develops a minimum of 25 lbs. holding force.
- B. Material and Finish: Match door hardware.

2.10 ALARM NOTIFICATION APPLIANCES (**White in Color**)

- A. Notification Appliances: The Contractor shall furnish and install Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).
 - 1. Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.
 - 2. Class B (Style 4) notification appliances shall be wired without requiring traditional in/out wiring methods; addressable "T" Tapping shall be permitted. Up to 63 appliances can be supported on a single channel.
 - 3. Each notification appliance shall contain an electronic module. This on-board module shall allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications.
- B. Audible: Horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.
- C. Visible/Only: Strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.
- D. Audible/Visible: Combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be

wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be capable of two-wire synchronization with one of the following options:

1. Synchronized Strobe with Horn on steady
2. Synchronized Strobe with Temporal Code Pattern on Horn
3. Synchronized Strobe with March Time cadence on Horn
4. Synchronized Strobe firing to NAC sync signal with Horn silenced

- E. Isolator Module: Isolator module provides short circuit isolation for notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:

1. Report faults to the host FACP.
2. On-board Yellow LED provides module status.
3. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

- F. Accessories: The contractor shall furnish the necessary accessories.

2.11 NAC Power Extender

- A. The Controller shall be a stand-alone panel capable of powering a minimum of 3 Signaling line circuits. Each channel shall be rated for 2.5 amps and support up to 63 notification appliances. Power and communication for the notification appliances shall be provided on the same pair of wires.
- B. SLC notification appliance circuits shall be Class B Style 4.
- C. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.
- D. The NAC extender panel may be mounted close to the host control panel or can be remotely located.

3. EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.
- B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:
1. Factory trained and certified personnel.
 2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
 3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

- A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.
- B. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler/stand pipe valve required to be supervised.
- C. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.3 WIRING INSTALLATION

- A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AHJ) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).
- B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.
- C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.
- D. Install all fire alarm system wiring in red conduit.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
- B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - 1. Factory trained and certified.
 - 2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - 3. International Municipal Signal Association (IMSA) fire alarm certified.
 - 4. Certified by a state or local authority.
 - 5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
- C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
- D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

- E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
- H. Final Test, Certificate of Completion, and Certificate of Occupancy:
 - 1. Test the system as required by the Authority Having Jurisdiction in order to obtain a certificate of occupancy.

3.5 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.
- B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.6 TRAINING

- A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.
 - 1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
 - 2. Schedule training with the Owner at least seven days in advance.

END OF SECTION 28 31 11

SECTION 28 55 00
RF SURVEY FOR IN-BUILDING TWO-WAY EMERGENCY RESPONDER COMMUNICATION
ENHANCEMENT SYSTEM

1. GENERAL

1.1 SUMMARY

1. The purpose of this specification is to establish the requirements and standards for initial survey for public safety radio signal strength per NFPA and IFC
2. Survey should be performed after the building is substantially completed, and prior to start of installation of electrical wiring.
3. Conduct a survey using a RF Spectrum Analyzer, a calibrated, system-compatible radio or another suitable instrument with traceable certificate of calibration to analyze the RF signal strength of Emergency Responder Radio Signal into the building and determine if amplification of the signal is required. Both inbound and outbound signal strength shall be determined, measured, calculated and documented as required by code.

1.2 SURVEY CRITERIA IF REQUIRED

1. The required Public Safety Radio Signal Level inside the Owner's facility must be determined per code, ordinance or AHJ
2. The minimum qualifications of the system designer and lead installation personnel shall include both of the following:
 1. A valid FCC-issued general radio operators license.
 2. Certification of in-building system training issued by a nationally recognized organization, school or a certificate issued by the manufacturer of the equipment being installed.

1.3 REGULATIONS

1. Codes, regulations and standards referenced in the Section are:
 1. NFPA 1 – The National Fire Code (including Annex O from 2009)
 2. NFPA 70 – The National Electrical Code
 3. IFC 510- Emergency Responder Radio Coverage
 4. NFPA 101, Life Safety Code, the Ohio Building Code, and Local Code and Building Authority requirements.
 5. NFPA 72 National Fire Alarm Code
 6. FCC 47 CFR Private Land Mobile Radio
 7. 90.219 Services-Use of Signal Boosters
 8. ICC International Fire Code, Code and Commentary
 9. Local or State Promulgated Fire Code
 10. ADA "Americans with Disabilities Act"
 11. FCC's OET 65 Standards "Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields"
 12. FCC Rules Part 22, Part 90 and Part 101
 13. NFPA 1221 2016 Edition or later
 14. International Building Code 2012 / 2015 / 2018 or later

1.4 DEFINITIONS

1. Definitions:

1. Bi-Directional Amplifier BDA / Fiber DAS Master/Remote: Device used to amplify band-selective or multi-band RF signals in the uplink, to the base station and in the downlink from the base station to subscriber devices for enhanced signals and improved coverage.
2. In-building Two-way Emergency Responder Communication Enhancement System: A two-way radio communication system installed to assure the effective operation of radio communications systems for fire, emergency medical services, or law enforcement agencies within a building or structure. A system used by firefighters, police, and other emergency services personnel.
3. FCC: Federal Communications Commission
4. OET 65 Standards: FCC's Bulletin 65 provides Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields.
5. Public Safety/First Responder: Public Safety or First Responder agencies that are charged with the responsibility of responding to emergency situations. These include, but are not limited to law enforcement departments, fire departments, and emergency medical companies.
6. RSSI: Received signal strength indicator RSSI is a measurement of the power present in a received radio signal.
7. BER: Bit Error Rate is the number of bit errors per unit time
8. GROL- FCC General Radio Operators License
9. ERCES- Emergency Responder Communication Enhancement System
10. DAS-Distributed Antenna System

PART 2. EXECUTION

2.1 TESTING PROCEDURES

1. Minimum Signal Strength: For testing system signal strength and quality, the testing shall be based on the. -95dBm nominal signal at 100%.
2. Spectrum Analyzer or Calibrated Handheld Radio or Scanning Receiver shall be used as basis for signal measurements or other method as approved by AHJ.
3. Testing should be based on a minimum of 20 grid locations per floor OR maximum of 1600 SQ ft. areas if the floor exceeds 32,000 Sq. Ft. Also, testing should include all critical areas per NFPA. See 1.02 of this specification and NFPA 72 2013 or NFPA 1221 2016. OR per any method determined by the AHJ, local code or ordinance.
4. A minimum signal strength of -95 dBm shall be provided throughout the coverage area for both uplink and downlink by the Local Fire Department.

- a. RSSI measurement only

2.2 SURVEY SUBMITTALS

1. Submit testing data for each level of the building.
 1. An RF measurement drawing of each floor of the building which indicates relative RF field strength for each frequency band of interest must be submitted to the AHJ.
 2. The drawing should indicate clearly the areas that have passed or failed based on the above parameters.

END OF SECTION 28 55 00

**SECTION 321313
CONCRETE PAVING**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Furnish and construct all exterior portland cement concrete as shown on Drawings and herein specified.
 - 1. Work to be included under this Section shall consist of the following:
 - a. Driveways, fire access lanes, dumpster approach, sidewalks, and any concrete pavement specified on the drawings.
- B. Related Work Specified Elsewhere:
 - 1. Section 312000 "Earth Moving"
 - 2. Section 321216 "Asphalt Paving"

1.2 QUALITY ASSURANCE

- A. Qualifications of Installers:
 - 1. Provide at least 1 person at all times during execution of this portion of Work and who is thoroughly familiar with the type of materials being installed and is directly responsible for all Work performed under this Section.
- B. Requirements of Regulatory Agencies:
 - 1. It is Contractor's responsibility to comply with the requirements of the regulatory agencies, including the purchase of any permits at their own expense.
- C. Construction Tolerances:
 - 1. Vertical alignment shall not vary more than 1/8 inch from the edge of a 10-foot straight edge.
 - 2. Horizontal alignment shall not vary more than 1/2 inch from the plan alignment for pavement.
 - 3. Concrete thickness shall not be less than specified.
 - 4. Reinforcing bars shall be placed to the following tolerances:
 - a. Clear distance to formed surface, plus or minus 1/4 inch.
 - b. Sheared length, plus or minus 1 inch.
 - c. Concrete cover on top bars in slabs and beams 8 inches deep or less, 2 inches plus or minus 1/4 inch.
 - d. Concrete cover on top bars in members 8 inches to 24 inches deep, 2 inches plus or minus 1/2 inch.
 - e. Crosswise or lengthwise spacing, plus or minus 2 inches provided minimum spacing and cover requirements are not violated.
- D. Referenced Standards:
 - 1. The current editions of the following American Concrete Institute (ACI) publications shall govern all Work performed hereunder, unless otherwise specified:
 - a. Recommended Practice for Concrete Floor and Slab Construction - ACI 302.
 - b. Recommended Practice for Hot Weather Concreting - ACI 305.
 - c. Recommended Practice for Cold Weather Concreting - ACI 306.
 - d. Recommended Practice for Construction of Concrete Pavements and Concrete Bases - ACI 316.
 - e. Building Code Requirements for Reinforced Concrete - ACI 318.
- E. Design Criteria:
 - 1. Contractor shall employ an approved independent materials testing laboratory and pay for the service of setting up the design mixes and to analyze the fine and

coarse aggregate for the various uses of concrete utilized on the project. Design mixes shall be in accordance with the previously cited ACI 318 publication and in compliance with this Specification. The proposed mixes shall be submitted to OWNER for approval prior to placing of any concrete. The approved mixes established by the laboratory shall be used in the Work as long as the characteristics of the ingredients remain unchanged. If any significant change is made in the ingredients, new mixes shall be prepared and submitted to OWNER for approval.

2. Concrete shall consist of a minimum 28 day compressive design strength of 4,000 psi using portland cement, aggregate, air entraining admixture, water and an air content ranging from 5 to 7 percent. Slump of concrete shall have a range of 2 to 4 inches.
 - a. If any of the conditions vary from those as described, Contractor shall submit a revised mix design prepared by the testing laboratory along with a written request for the variance desired to OWNER for their consideration and approval.
 - b. Concrete for portions of the structure required to be watertight, such as water storage, pumpstation wetwells and waste treatment tanks, shall be air-entrained and have a water-cement ratio not exceeding 0.48.
 - c. Admixtures shall be used only with the approval in writing by OWNER. All admixtures shall be used in accordance with the manufacturer's instructions and shall be added at the plant. Calcium chloride shall not be used as an admixture.
 - d. Mix designs shall be based on Type I cement. Type III (high early) cement or any other types of cement shall be used only when approved in writing by OWNER. When high-early cement is used, the 7-day strength test shall exceed the specified 28-day strength tests.

1.3 SUBMITTALS

- A. Product Data:
 1. Prepare and submit product data for OWNER'S approval. Product data shall include manufacturer's recommended installation instructions.
- B. Samples:
 1. If requested by OWNER, submit samples for approval of proposed materials.
- C. Certification:
 1. Submit 3 copies of certification of material compliance as requested by OWNER.
- D. Delivery Tickets:
 1. Submit a delivery ticket with each truck load of concrete delivered which indicates OWNER'S design mix, truck number, project number, Contractor, ready mix producer, time of batching and total yards of concrete.
- E. Test Reports and Design Mixes:
 1. Submit 3 copies of design mixes and material test reports to OWNER.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Form Material:
 1. Form material shall be either sound lumber or steel, free of defects and variations in dimensions. The sides of all lumber shall be surfaced and matched to prevent mortar leakage. Metal forms shall be of standard manufacture and need not be new, but shall be free from rust and dirt. Metal forms shall be flat and true to line without punctures. All form material shall be sized and of strength to resist movement during concrete placement and to retain horizontal and vertical

alignment until removal of same.

- a. Rigid forms are to be utilized on tangent alignment and curves having a radius of 150 feet or greater.
- b. Curved forms shall be utilized on the curved Work with a radius of 150 feet or less, and shall consist of flexible spring steel or laminated lumber.

B. Reinforcement Materials:

1. Reinforcing bars and dowels shall be of new billet steel conforming to ASTM A615, Grade 60 (60,000 psi yield). Sizes of bars shall be as indicated on Drawings or herein specified.
 - a. Dowel bars when used for contraction and expansion joints shall be smooth steel bars coated with a thin uniform coating of liquid asphalt (MC-250) or grease on 1/2 the length of the bar plus 2 inches. In addition, dowel bars for expansion joints shall be furnished with end caps designed with one end closed, a minimum length of 3 inches and be positioned to allow bar movement of not less than 1 inch.
 - b. Dowel bar assemblies may be permitted if fabricated to the width of the pavement section.
 - c. Tie bars for control, longitudinal and construction joints shall be deformed bars.

C. Concrete Materials:

1. Portland cement shall conform to ASTM C150.
 - a. Cement shall be a low alkali cement (Type I) containing not more than 0.6 percent by weight of tri-sodium silicate oxide.
2. Coarse aggregate shall conform to Size 57 grade requirements of Table 2 of ASTM C33 standard.
3. Fine aggregate shall conform to ASTM C33 with fineness modulus not to vary more than 0.20 from value assumed in design mix.
4. Water shall be potable, clean and free from deleterious amounts of acid, alkali or organic material.

D. Admixtures:

1. Air entraining agent shall conform to ASTM C260 and shall be added at the mixer.
2. Water reducing agents, (such as super plasticizers), retarding agents, accelerating agents and all other admixtures, shall require approval by OWNER and if used, shall conform to ASTM C494. In no case shall admixtures be permitted as substitute for cement content specified, unless approved by OWNER.

E. Expansion Joint Material:

1. Joint filler material shall consist of a non-extruding standard bituminous bound type "Sealtight Asphalt Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois or OWNER approved equal.
 - a. Material shall conform to ASTM D994.
2. Joint filler material shall consist of preformed non-extruded bituminous bound type "Sealtight-Fibre Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois; "Code 1390" as manufactured by W.R. Grace Company, Cambridge, Massachusetts or OWNER approved equal.
 - a. Material shall conform to ASTM D1751.
 - b. Material shall be 1/2 inch thick, unless otherwise noted, of widths equal to slab thickness less 1/2 inch or as otherwise indicated.
3. Joint sealant shall be a single component, polyurethane type "Sikaflex-la" as manufactured by Sika Chemical Corporation, Lyndhurst, New Jersey or OWNER approved equal. Color as selected by OWNER.

- F. Curing Materials:
1. Kraft paper shall be waterproof and nonstaining "Sisalkraft 5K-10" conforming to ASTM C171.
 2. Polyethylene film shall be white opaque sheet or roll material not less than 0.006 inch thick (6 mil) conforming to AASHTO-M171.
 3. Contractor may at their option use a liquid curing compound for surfaces that will not receive treating oil or waterproofing membrane. Liquid curing compound shall conform to ASTM C309 and shall consist of the following:
 - a. Type 1D, translucent with fugitive dye.
 - b. Type 2, white pigmented, Class B (vehicle solids restricted to all resin).

2.2 PRODUCTION

- A. Concrete shall be ready-mixed, and shall be batched, mixed and transported in accordance with "Specification for Ready-Mixed Concrete" ASTM C94. The production plant equipment and facilities shall meet the requirements of the National Ready Mixed Concrete Association.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

- A. Hot Weather Conditions:
1. The following precautions shall be adhered to:
 - a. Reject concrete mixture having temperature of 85°F or greater.
 - b. Pre wet subgrade.
 - c. Crushed or flaked ice may be utilized in reducing temperature of mixture.
 - d. If necessary, reduce temperature of reinforcing steel with wet burlap.
 - e. Reduce mixing time (agitating time) in truck to 45 minutes.
 - f. During periods of high winds, shelter windward side with adequate wind breaks.
 - g. Apply no chemical retarder to finished surface unless permission is granted in writing by OWNER.
- B. Cold Weather Conditions:
1. When ambient temperature is 40°F or less, the following precautions are to be adhered to:
 - a. Subbase shall not be frozen.
 - b. Concrete mixture delivered at Worksite shall be 55°F (minimum), 85°F (maximum).
 - c. No calcium chlorides, salts or other chemical accelerators shall be permitted, unless otherwise acceptable in writing by OWNER.
 - d. Concrete surface shall be maintained at a minimum of 50°F with appropriate thermal insulation for a period of 7 days (normal concrete), 3 days (high early-strength concrete).
 - e. Refer to previously cited ACI 306 for minimum thickness of thermal protection required.
 - f. Any concrete that has frozen or disintegrated as a result of freezing shall be removed and replaced at Contractor's expense.

3.2 SUBGRADE PREPARTION

- A. Fine grade and compact subgrade to the plan cross section. Compaction shall be as specified in Section 312000 of this Specification or as indicated on the Drawings.
- B. After compaction, cut-out soft spots and unstable areas in the subgrade and fill with select fill material and compact as specified in Section 312000.

3.3 GRANULAR BASE

- A. Construct the select fill and granular base as shown on Drawings on the prepared subgrade after the final shaping and compacting of the subgrade is completed.
- B. Compact as specified base in Section 312000 of this Specification.

3.4 FORM CONSTRUCTION

- A. Forms shall have the strength and rigidity, regardless of material, such that when they are set in place and braced, they will withstand weight of equipment and weight of concrete without settlement or lateral displacement.
- B. Keyway forms in the edge of pavement slabs and at construction joints shall be constructed to the dimensions shown on Drawings. Wood keyway forms, if used, shall be bolted or nailed to the side forms. Metal keyway forms shall be fixed or held rigidly in place by staking or other OWNER approved method.
- C. Forms shall be coated prior to the placement of concrete, with a nonstaining form release agent. Wooden form may be prewetted with water. No standing water, adjacent to forms, shall be permitted.

3.5 REMOVAL OF FORMS

- A. Forms for slabs on grade shall not be removed earlier than 12 hours after the placement of concrete has been completed. Within 24 hours of form removal backfill adjacent to the pavement shall be completed.
- B. Forms supporting the weight of concrete shall not be released until the concrete has reached its specified 28-day strength. Minimum time elapse after casting and before the false Work supports are released shall be 8 days for spans up to 96 inches center to center of supports, plus 1 additional day for each 12 inches of increase in span length over 84 inches up to 14 days for span of 14 feet and over. Such time period shall be exclusive of those time intervals during which the concrete surface temperature is below 40°F. If temperature remains below 40°F during the casting and curing period no forms shall be removed until approved field tests indicating adequate concrete strength have been provided.

3.6 REINFORCEMENT PLACEMENT

- A. Tie bars, reinforcement bars and dowel bars shall be clean, free from rust and shall be placed on adequate supports in locations as shown on Drawings. Provide the following minimum thickness of concrete cover:
 - 1. Concrete deposited on ground: 3 inches
 - 2. Formed surfaces against ground: 1-1/2 inches
 - 3. Beams, girders and columns: 1-1/2 inches
 - 4. Slabs, walls and joists: 1 inch
 - 5. Clear distance between parallel bars: 1 inch or nominal bar distance
 - 6. For No. 6 bars or larger: 2 inches
 - 7. No broken brick, block or concrete shall be permitted as reinforcement supports.
- B. Welded steel wire fabric shall be placed free from rust, kinks and bends and shall be cut in such a way that the overlap measured between outermost cross wires of each fabric sheet is not less than 2 inches. The fabric shall be cut at contraction joints. It shall be supported by a layer of fresh concrete placed to the depth of the mesh shown on Drawings, followed by placement of the upper layer of concrete.

3.7 JOINTS

- A. General:
 - 1. Construct expansion, contraction and construction joints with face perpendicular to surface of concrete.
 - 2. Where joining existing structures, match existing contraction or expansion joints.

- B. Expansion Joints:
 - 1. All fixed objects, such as buildings and structures or pavement, sidewalks or curb intersections shall be separated by a 1/2 inch expansion joint placed at the full depth of the concrete thickness. Expansion joints, in addition to the above, shall be placed at 60 foot intervals in the following:
 - a. Concrete curb and gutter
 - b. Concrete walk
- C. Construction Joints:
 - 1. Contraction joints shall be placed at the following intervals and dimensions or as shown on Drawings:
 - a. Concrete curb and gutter – 10 feet; 1/8 inch wide by 1 1/2 inch depth.
 - b. Concrete walk – 10 feet; 1/8 inch wide by 1/4 the depth of concrete.
 - 2. Cut plastic concrete with appropriate tool to specified depth. Finish edges with 1/4 inch radius tool.
 - 3. Saw-cut joints to specified width and depth on hardened concrete as soon as concrete has hardened sufficiently to prevent raveling or damage to the joint.
- D. Joint Sealer:
 - 1. Apply joint sealer to a clean and dry expansion or contraction joint if specified to a point approximately 1/4 inch below the top surface. Where oil treatment is specified, joint sealer shall be applied prior to application of the oil.

3.8 CONCRETE PLACEMENT

- A. Place concrete to required depth and width to form a continuous mass requiring a minimum of rehandling. Concrete adjacent to side forms and fixed structures shall be consolidated by means of portable vibrators or by mechanical means with the use of hand spading. Vibrators shall not be used to move concrete horizontally.
- B. If it is necessary to place a construction joint prior to a contraction joint, the distance between the construction joint and the previous contraction joint shall not be less than 60 inches.
- C. Automatic machine may be used for curb and gutter placement at Contractor's option, if acceptable to OWNER. If machine placement is to be used, submit revised mix design and laboratory test results, which meet or exceed the minimum herein specified. Machine placement must produce curbs and gutters to the required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.9 CONCRETE FINISH

- A. After initial strike-off and floating, and prior to finishing, test surface with 10-foot straightedge. Correct irregularities prior to final finishing operations.
- B. Apply the following surface finish after surface sheen or excess moisture has disappeared:
 - 1. Apply steel trowel finish followed by stiff-bristled broom drawn across concrete surfaces, perpendicular to line of traffic:
 - a. Sidewalk
 - b. Concrete pavement
 - c. Curb and gutter

3.10 CONCRETE CURING AND PROTECTION

- A. Cure concrete surfaces for 7 days (normal concrete) and for 3 days (high early-strength concrete), using appropriate means of protection as previously cited in ACI 305 and ACI 306.

- B. Curing methods shall consist of one of the following:
1. Keep concrete surface continuously wet by ponding with water.
 2. Apply moisture proof fabric to entire area lapping joints and edges at least 3 inches. Tape interior joints and weight edges down with sand or other approved material.
 3. Apply liquid membrane curing compound to the finished surface in a 2 coat continuous operation with second application applied transversely to the direction of the first application, and in accordance with the manufacturer's directions. Replace damaged areas with equal applications of membrane using compound. Liquid membrane curing compound shall not be permitted where the surface will be subjected to an application of waterproof coatings, bonding agents, treating oil or paint.

3.11 TESTING AND EVALUATION

- A. Concrete materials and operations shall be tested and inspected as the Work progresses, by an independent testing laboratory. Contractor shall furnish any necessary labor who is familiar with methods of sampling and shall assist the testing agency in obtaining and handling samples, and for safe storage and proper curing of concrete test specimens on Worksite.
- B. Mold and cure three standard 6-inch diameter specimens from each sample in accordance with ASTM C31. Compressive strength test specimens shall be in accordance with ASTM C39. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded. When high-early strength concrete is used, the first specimen shall be tested at 3 days; the remaining two at 7 days.
- C. Make at least one strength test for each 50 cubic yards, or fraction thereof, of each mix design of concrete placed in any one day.
- D. Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, using standard slump cone as per ASTM C143.
- E. The testing laboratory shall report all test and inspection results to OWNER, OWNER'S Engineer, and Contractor immediately after they are performed. All concrete test reports shall include name of job, date of placement, date of test, batch mix design, slump and the exact location in the Work at which the batch represented by the test was deposited.
- F. All costs necessary to prepare concrete test cylinders, make tests and furnishing of written reports shall be borne by the Contractor.

3.12 DEFECTIVE WORK

- A. When tests and inspections of the aggregate base and/or concrete Work indicate non-compliance with the Specification, Contractor and OWNER shall mutually agree on the number and location of additional tests to define and/or verify the deficiency. If the average of the tests for a given area indicate non-compliance the area is considered defective and Contractor shall:
1. Remove and replace defective Work at no cost to OWNER;
 2. Correct the Work at no cost to OWNER in a manner acceptable to OWNER;
 3. Give OWNER a credit towards the Contract Price if it is acceptable to OWNER;
 4. If Work is found to be in noncompliance, Contractor shall pay for the defective area removal and replacement, and the tests and inspection costs; or
 5. If Work is found to be in compliance, OWNER shall pay for tests and inspection costs.

END OF SECTION 321313

**SECTION 321373
CONCRETE PAVING JOINT SEALANTS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
 - 2. Hot-applied joint sealants.
 - 3. Joint-sealant backer materials.
 - 4. Primers.

1.2 PREINSTALLATION MEETINGS

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

1.3 ACTION SUBMITTALS

- A. Product Data: for each type of product
- B. Samples for Initial Selection: Manufacturer's standard color sheets, showing full range of available colors for each type of joint sealant.
- C. Paving-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

- A. Product certificates.

PART 2 - PRODUCTS

2.1 JOINT SEALANTS, GENERAL

- A. Compatibility: Provide joint sealants, backer materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANT

- A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.
- B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.
- C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.
- D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.
- E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANT

- A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I.
- B. Hot-Applied, Single-Component Joint Sealant ASTM D 6690, Type I or Type II.
- C. Hot-Applied, Single-Component Joint Sealant ASTM D 6690, Type I, II, or III.
- D. D 6690, Type IV.

2.4 JOINT-SEALANT BACKER MATERIALS

- A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 - EXECUTION

3.1 INSTALLATION OF JOINT SEALANTS

- A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
- C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.
- D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.
- E. Install joint-sealant backers to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backer materials.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backer materials.
 - 3. Remove absorbent joint-sealant backer materials that have become wet before sealant application and replace them with dry materials.
- F. Install joint sealants immediately following backer material installation, using proven techniques that comply with the following:
 - 1. Place joint sealants so they fully contact joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants in accordance with the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 - 1. Remove excess joint sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
- I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION 321373

**SECTION 329113
SOIL PREPARATION**

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes materials, labor, apparatus, tools, equipment, temporary construction, transportation, and services necessary for and incidental to performing the proper completion of Work, as required to make a complete and thorough preparation of the planting soil, including soil amendment products, imported topsoil, as required, to make up deficiencies in quantity of soil available on site, as shown in the Contract Drawings, and as specified herein this Section.
- B. Work under this Section consists of, but is not necessarily limited to, furnishing and installing the following:
 - 1. Agronomic Soil Fertility Testing and Soil Percolation Testing.
 - 2. Topsoil.
 - 3. Pre-Plant Weed Control.
 - 4. Soil Conditioners, Amendments and Fertilizers (Organic & Chemical).
- C. Related Requirements:
 - 1. Section 312000 "Earth Moving"
 - 2. Section 329300 "Plants" for placing planting soil for plantings.
 - 3. Section 328400 "Landscape Irrigation Performance Specification"
 - 4. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.

1.2 DEFINITIONS AND APPLICABLE STANDARDS

- A. References:
 - 1. USDA – United States Department of Agriculture.
 - 2. ASTM – American Society for Testing & Materials.
- B. Definitions:
 - 1. Topsoil - Shall be friable soil, providing sufficient structure in order to give good tilth and aeration to the soil. Topsoil shall be free of roots, clods, stones larger than one-inch (1") in the greatest dimension, pockets of coarse sand, noxious weeds, sticks, lumber, brush and other litter. It shall not be infested with nematodes or other undesirable disease-causing organisms such as insects and plant pathogens.
 - 2. Gradation Limits - Soil shall be a sandy loam, loam, clay loam or clay. The definition of soil texture shall be per the USDA classification scheme. Gravel over ¼-inch in diameter shall be less than 20% by weight.
 - 3. Permeability Rate - Hydraulic conductivity rate shall be not less than one-inch (1") per hour, nor more than twenty-inches (20") per hour, when tested in accordance with the USDA Handbook Number 60, Method 34b, or other approved Methods.
 - 4. Fertility - The range of the essential elemental concentration in soil shall be as follows: (cont. next page) Ammonium Bicarbonate/DTPA Extraction (PPM) Element Concentration of elements for Soil Selection, measured as mg/kilogram dry weight basis Concentration of Elements for Final Acceptance (amended and conditioned soil) measured as mg/kilogram dry weight basis Phosphorus 2 - 40 10 - 40 Potassium 40 - 220 100 - 220 Iron 2 - 35 24 - 35 Manganese 0.3 - 6 0.6 - 6 Zinc 0.6 - 8 1 - 8 Copper 0.1 - 5 0.3 - 5 Boron 0.2 - 1 0.2 - 1 Magnesium 50 - 150 50 - 150 Sodium 0 - 100 0 - 100 Sulfur 25 - 500 25 - 500 Molybdenum 0.1 - 2 0.1 - 2
 - 5. Acidity - The soil pH range measured in the saturation extract (Method 21a, USDA Handbook Number 60) shall be 6.0 - 7.9.
 - 6. Salinity - The salinity range measured in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 0.5 - 2.0 dS/m. If calcium and if sulfate ions both exceed 20 milli-equivalents per liter in the saturation extract, the maximum salinity

shall be 4.0 dS/m.

7. Chloride - The maximum concentration of soluble chloride in the saturation extract (Medoth3a, USDA Handbook Number 60) shall be 150 mg/1 (parts per million).
8. Boron - The maximum concentration of soluble boron in the saturation extract (Method 3a, USDA Handbook Number 60) shall be 1 mg/1 (parts per million).
9. Sodium Adsorption Ratio (SAR) - The maximum SAR shall be 3 measured per Method 20b, USDA Handbook Number 60.
10. Aluminum – Available aluminum measured with the Ammonium Bicarbonate/DTPA Extraction shall be less than 3.0 parts per million.
11. Soil Organic Matter Content - Sufficient soil organic matter shall be present to impart good physical soil properties but not be excessive to cause toxicity or cause excessive reduction in the volume of soil due to decomposition of organic matter. The desirable range is 3% to 5%. The carbon/nitrogen ratio should be about 10. A high carbon/nitrogen ratio can indicate the presence of hydrocarbons or non-humified organic matter.
12. Calcium Carbonate Content - Free calcium carbonate (limestone) shall not be present in acid-loving plants.
13. Heavy Metals - The maximum permissible elemental concentration in the soil shall not exceed the following concentrations: (cont. on next page) Ammonium Bicarbonate/ DTPA Extraction (PPM) Element (mg/kilogram) dry weight basis
Arsenic 1.0 Cadmium 1.0 Chromium 10.0 Cobalt 2.0 Lead 30.0 Mercury 1.0 Nickel 5.0 Selenium 3.0 Silver 0.5 Vanadium 3.0
 - a. If the soil pH is between 6 and 7, the maximum permissible elemental concentration shall be reduced 50% to the above values. If the soil pH is less than 6.0, the maximum permissible elemental concentration shall be reduced 75% of the above values. No more than three (3) metals shall be present at 50% or more of the above values.
14. Phytotoxic constituent, herbicides, hydrocarbons, etc. – Germination and growth of plants shall not be restricted more than 10% compared to the reference soil. Total petroleum hydrocarbons shall not exceed 50 mg/kg dry soil measured per the modified EPA Method No. 8015. Total aromatic volatile organic hydrocarbons (benzene, toluene, xylene and ethylbenzene) shall not exceed 0.5 mg/kg dry soil measured per EPA Method No. 8020.
15. Sub Grade - Soil level resulting from the rough grading work under another Section. Cultivation of sub grade areas prior to placement of Topsoil is included in this Section.
16. Stockpiled Topsoil - Soil stockpiled for spreading over prepared sub-grade.
17. Stockpiled Native Topsoil - Topsoil stripped from the site prior to rough grading Work (under another Section), to be spread and amended as Work under this Section.
18. Imported Topsoil - Off-site Topsoil, imported and stockpiled under this Section, to be spread and amended as Work under this Section.

C. Measurements:

1. PPM: Measurement, in parts per million.

1.3 QUALITY ASSURANCE

A. Installer Qualifications for requirements indicated herein this Section:

1. Licensed Landscape Contractor, in the State of Arkansas.
 - a. Engage an experienced, licensed Contractor who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
 - b. Installer's Field Supervision: Contractor shall maintain an experienced, full-time landscape supervisor/superintendent at the Project Site during times that landscaping operations identified herein the Contract are in progress.

- B. Manufacturer's Directions: Follow Manufacturer's directions and drawings in cases where the Manufacturers of articles used in this Section furnish directions covering points not shown in the Contract Drawings or Contract Specifications.
- C. Permits, Fees, Bonds, Testing, and Inspections: Contractor shall arrange and pay for permits, fees, bonds, testing, and inspections necessary to perform and complete his portion of the Work.
- D. Approved Testing Laboratory and Procedures for Agronomic Soil Fertility Analyses:
 - 1. Agronomic Soil Fertility Analyses shall be conducted by a reputable, certified, agronomic soils laboratory. Laboratory shall be a member of the Council on Soil Testing and Plant Analysis. The same laboratory shall be used throughout the duration of the Contract:
 - 2. Contractor shall verify and confirm the selected Testing Laboratory and specific location(s) of soil sample(s) with the Landscape Architect prior to commencing soil sampling operations.
 - 3. For each Soil type, submit the physical Soil Samples directly to the selected Laboratory for analysis, per the procedures outlined per Part III herein this Section.
 - a. In addition to the physical Soil Samples, Contractor shall also provide the Laboratory with a copy of the Soil Amendment and Fertilizer products indicated herein this Section.
 - 4. Along with the testing data results, the Agronomic Soil Fertility Analysis shall also include written recommendations authored by the Laboratory conducting the Analyses for amending, treating, and/or correcting the sampled soils. Laboratory shall utilize the organic-based Soil Amendments and Fertilizers described herein this Section to the greatest extent possible to produce satisfactory planting soil(s) suitable for sustaining healthy viable plant growth.
 - a. The Analyses shall also include Maintenance and Post-Maintenance fertilization programs for planted areas within the Contract.
 - 5. Agronomic Soil Fertility Analyses shall be performed on each Soil Type samples, and include testing results for the following pH Electro-conductivity (salinity) measurement – saturated extract. Measurement of sodicity (Sodium Absorption Ratio) Estimate of soil texture and soil organic matter Presence of lime Nutrients/Toxic Elements measurement of DPTA extract Saturation extracts for nitrate, sulfate, sodium, calcium, magnesium, potassium, soluble phosphate, and boron Parasitic nematodes Herbicide contamination (For Lightweight Soil Mixes) Test for physical and chemical composition, and saturated weight per cu.ft.
 - 6. Planting operations shall not commence until the results of the Agronomic Soil Fertility Analysis and Recommendations are reviewed accordingly by the Landscape Architect.
 - 7. The quantity or type of amendments may be modified by the Landscape Architect within fourteen (14) days of receipt of the results. The Agronomic Soil Fertility Analysis and Recommendations shall take precedence over the amendment and fertilizer application rates specified herein or on the Contract Documents.
 - 8. The Agronomic Soil Fertility Report/Recommendation shall take precedence over the amendment and fertilizer application rates specified herein or on the Contract Documents.

1.4 SUBMITTALS

- A. General:
 - 1. Collect information into a single Submittal for each element of construction and type of product or equipment identified under this Section for review.
 - 2. Submittal Format: As applicable, furnish Submittal as a single electronic digital PDF (Portable Document Format) file.
- B. Digital Submittal Information:

1. Product/Material Data: Submit available product/material literature supplied by manufacturer's, indicating that their products comply with specified requirements. Provide manufacturing source (name, address, and telephone number), and distributor source (name, address, and telephone number) for each type of product/material.
 - a. Planting Soil (Imported/Amended Topsoil).
 - b. Soil Amendments (for each type used, for Sand, Perlite, Peat Humus, Gypsum, Soil Sulfur, Iron, etc).
 - c. Bulk Composted Organic Soil Amendment Material.
 - d. Granular Soil Conditioning Material.
 - e. Mycorrhizal Inoculum.
 - f. Fertilizers (for each type used).
 2. Agronomic Soil Fertility Analysis and Recommendations: Submit a minimum of fourteen (14) days prior to amending of the soil and ordering soil amendments. The locations of where each of the soil test samples were derived from the Project Site shall be keyed to the site plan and shall be included with the results.
 3. Qualification Data: Submit names for firms and persons specified in the "Quality Assurance and Control" Article to demonstrate their capabilities and experience on similar installations.
- C. Material Samples: Submit four (4) sets of physical Material Samples for review of kind, color, pattern, size, and texture for a check of these characteristics with other elements, and for a comparison of these characteristics between Submittal and actual component as delivered and installed. Include the full range of exposed color and texture expected in the completed work. Provide Material Samples bound and individually wrapped in re-sealable labeled 1-gallon plastic bags (as applicable):
1. Provide Material Sample sets for each item submitted under Product/Material Data.
- D. Submittals under this Article will be rejected without the benefit of review by the Landscape Architect if they are difficult to read due to insufficient scale, poor image quality, or poor drafting quality; or if the required information is missing or not presented in the format as requested.
- E. No Work shall proceed under this Section until Submittal requirements indicated herein have been reviewed accordingly by the Landscape Architect.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. General: Deliver and install materials so as to not delay Work and install only after preparations for installation have been completed.
- B. Packaged Materials Deliver packaged materials in original, unopened packages or containers, with manufacturer's labels intact and legible, showing weight, analysis, and name of manufacturer. Store and secure properly to prevent theft or damage.
1. Store packaged materials off ground and under cover, away from damp surfaces and inclement weather.
 2. Protect during storage and construction against soilage or contamination from earth and other materials.
- C. Bulk Materials:
1. Deliver and store bulk materials so as not to impede Work of others.
 2. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 3. Protect during storage and construction against soilage or contamination from earth and other materials. Provide adequate separation between bulk materials so as not to cross-contaminate bulk materials.
 4. Store under cover, away from inclement weather.
 5. Provide erosion-control measures to prevent erosion or displacement of bulk

materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

6. Do not move or handle materials when they are wet or frozen.
7. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates. Furnish original certificates to Landscape Architect upon request.

1.6 COORDINATION, SCHEDULING, AND OBSERVATIONS

- A. Notify the Contractors performing Work related to installation of Work under this Section in ample time to allow sufficient time for them to perform their portion of Work and that progress of Work is not delayed. Verify conditions at the Project Site for Work that affects installation under this Section. Coordinate items of other trades to be furnished and set in place.
- B. Utilities: Determine location of above grade and underground utilities and perform Work in a manner which will avoid damage to utilities. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by parties concerned.
- C. Excavation: When conditions detrimental to adequate Soil Preparation operations are encountered, such as rubble fill, adverse drainage conditions, or obstructions, cease operations and notify Landscape Architect for further direction.
- D. Installation: Perform Soil Preparation operations only when weather and soil conditions are suitable in accordance with locally accepted practices.
- E. Construction Site Observations: Periodic site observations shall be made by the Landscape Architect during the installation of Work under this Section for compliance with requirements for type, size, and quality. Landscape Architect retains right to observe Work for defects and to reject unsatisfactory or defective material at any time during progress of Work. Contractor shall remove rejected materials immediately from Project site, all associated cost are to be paid by the contractor.

1.7 SITE CONDITIONS

- A. Project Site shall be free of weeds, native grasses, evasive grasses, (Bermuda Grass, Johnson Grass, Nut Grass, etc.) prior to Topsoil distribution or soil amendment placement.
- B. Excessive rock, dead or declining vegetation, trash, debris, or other items that has accumulated throughout the duration of the Project shall be removed from the Project Site by the Contractor, and as directed by the Landscape Architect.
- C. Grading and soil preparation Work shall be performed only during the period when beneficial and optimum horticultural results may be obtained. If the moisture content of the soil should reach such a level that working it would destroy soil structure or cause compaction, spreading and grading operations shall be suspended until, in the opinion of the Landscape Architect, the moisture content is increased or reduced to acceptable levels and the desired results are likely to be obtained.
 1. Soil moisture level prior to planting shall be no less than 75% of field capacity. The determination of adequate soil moisture for planting shall be in the sole judgment of the Landscape Architect.
 2. If the soil moisture level is found to be insufficient for planting, planting pits shall be filled with water and allowed to drain before commencing planting operations.
- D. Planting areas which become compacted in excess of 85% relative compaction due to construction activities shall be tilled and thoroughly cross-ripped to a minimum depth of twelve-inches (12") to alleviate the condition, taking care to avoid all existing subsurface utilities, drainage, etc.

PART 2 - PRODUCTS

2.1 PLANTING SOIL (TOPSOIL)

- A. Topsoil: Meet ASTM D5268, pH range of 5.5 to 7, 4 percent organic material minimum.

1. Topsoil Source: Reuse native surface soil stockpiled on the site. Verify suitability of native surface soil stockpiled on site to produce Topsoil meeting requirements; amend, as necessary. Supplement native surface soil stockpiled on site with imported Topsoil when quantities are insufficient.
 - a. Composition: Fertile, friable, well-drained soil, of uniform quality, free of stones over one-inch (1") diameter or larger in any dimension sticks, oils, chemicals, plaster, concrete, roots, plants, sod, and other deleterious or extraneous materials harmful to plant growth.
 - b. Obtain an Agronomic Soil Fertility Report/Recommendation of the stockpiled Topsoil from the approved Testing Laboratory indicated herein this Section.
 - c. Test Results: Request Testing Agency to send one (1) copy of test results direct to the Landscape Architect and one (1) copy to the Owner. Amend as required.
2. Topsoil Source Provide Imported Topsoil obtained from off-site sources, from naturally well-drained sites do not obtain from bogs or marshes.
 - a. Quantity: Provide Imported Topsoil as soon as an insufficient quantity of native stockpiled surface soil is verified. Quantity of Imported Topsoil to complete the Work shall be calculated by Contractor
 - b. Stockpiling: Stockpile on site as directed by Owner.
 - c. Composition: To match in quality, accepted native stockpiled Topsoil.
 - d. Analysis: Obtain an Agronomic Soil Fertility Report/Recommendation of the Imported Topsoil from the approved Testing Laboratory indicated herein this Section.
 - e. Review: Landscape Architect reserves the right to take samples of the Imported Topsoil delivered to the site for conformance to the Contract Specifications.
 - f. Rejected Imported Topsoil: Immediately remove rejected Imported Topsoil off site, at Contractor's expense.

2.2 SOIL MIXES/BLENDS (BACKFILL/PLANTING MIX)

- A. Soil Conditioner Blend, for amending on-site native soil planting surfaces, stockpiled, plant back fill or imported topsoil: Furnish a thoroughly blended composition of Bulk Composted Organic Soil Amendment Material and Granular Soil Conditioning Material & Fertilizer. Any substitution for the "Soil Conditioner Blend" listed herein must be requested by the Contractor and approved, in writing, by the Landscape Architect at least thirty (30) days prior to installation.
 1. Bulk Composted Organic Soil Amendment Material:
 - a. Material Composition: Bulk Composted Organic Soil Amendment Material shall be thoroughly cured for a minimum of 100 days, and shall be free from any trash (glass, metal, plastic, etc.) deleterious materials, bio-solids, and/or toxic chemicals. The Material shall be non-hazardous, and conform to US Environmental Protection Agency 40 CFR503 criteria for "Class A" products. It shall also exceed standards and specifications for unrestricted application as a landscaping and agricultural soil amendment.
 - b. Humus material shall have an acid-soluble ash content of no less than 6% and no more than 20%. The organic matter content shall be at least 50% on a dry weight basis.
 - c. Types of acceptable products are composts, manures, mushroom composts, straw, alfalfa, peat mosses etc. low in salts, low in heavy metals, free from weed seeds, free of pathogens and other deleterious materials.
 - d. Composted wood products are conditionally acceptable . Wood based products are not acceptable which are based on red wood or cedar.
 - e. Sludge-based materials are not acceptable.
 - 1) Gradation/Screen Analysis: A minimum of 90% of the material by

weight shall pass a 1/2" screen. Material passing the screen shall meet the following criteria: Percent Passing Sieve Designation 80 – 100% 6.35 mm (1/4") 50 – 80% 2.38 mm (No.8) 0 – 40% 500 micron (No.35)

- 2) Maturity: Physical characteristics suggestive of maturity include shall include:
 - a) Color: Dark brown to black.
 - b) Odor: Aerobic, without malodorous presence of decomposition products.
 - c) Particle characterization: Identifiable wood pieces are acceptable, but the balance of Material should be soil-like without recognizable grass or leaves.
 - d) Analytical Properties: Contractor shall submit proof of the Bulk Composted Organic Soil Amendment Material by providing a sample as identified herein this Section, and a lab analysis that has been performed within 30 days of the installation of the planting. Soil mix shall have (at a minimum) the following properties: Material Minimum Targeted Property/Range Total Nitrogen (N%) .50-1.0% Phosphorus (as P2O5) 2.0% Potassium (as K2O) 0.2% pH (units) 6.0 to 7.5, as determined in saturated paste. Organic Content Minimum 50% based on dry weight and determined by ash method. Minimum 205 lbs. organic matter per cubic yard of compost. ECe (millimho/cm) 5.0; based on pre-leaching with equal volume of water. Carbon-to-Nitrogen Ratio 25-to-1, nitrogen stabilized. Bulk Density 1,000 to 1,100 pounds/cubic yard. Sodium Absorption Ratio (SAR) Under 20.0 Total Iron 1.5% - 3.0% Moisture Content 35%-60% Acid-soluble Ash content No less than 6% and no greater than 20%. Salt Content 10millimho/cm @ 25d C. on a saturated paste extract. Boron Content 1.0 parts per million on a saturated paste extract. Silicon-Content (acid-insoluble ash) 50% Calcium Carbonate No presence on alkaline soils. Maximum Total Permissible Pollutant Concentrations Parts per million (mg/kg dry-weight basis) • Arsenic: 1.0 • Cadmium: 1.0 • Chromium: 10.0 • Cobalt: 2.0 • Copper: 1.0 • Lead: 30.0 • Mercury: 1.0 • Molybdenum: 2.0 • Nickel: 5.0 • Selenium: 1.0 • Silver: 0.5 • Vanadium: 3.0 • Zinc: 2.0
 - e) Application Rate: As indicated herein this Section under "Planting Soil Amendments Schedule".
 - f) Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
- 3) Provide submittal and sample to be approved by the Landscape Architect

2. Granular Soil Conditioning Material & Fertilizer:

- a. Material Composition and Analytical Properties: Granular Soil Conditioning Material & Fertilizer shall be a singular manufacturer-blended combination of soil conditioning material and fertilizer. It shall be granular in form, long-lasting, free flowing, and suitable for application with approved equipment. It shall not contain any sewage sludge or manure-based products, and shall contain the following guaranteed minimum available analysis range:
Element/Material Targeted Property Range Nitrogen (N) 5.0% to 6.0% Phosphoric Acid (as P2O5) 2.0% to 3.0% Potash (as K2O) 1.0% to 4.0%

- Humic Acids 15.0 % to 20.0% Calcium 7.0% Sulfur 0.0% to 5.0%
- b. Commercial-Grade Products, Manufacturers and Associated Rates of Application: Subject to compliance with requirements.
 - 1) Provide submittal and sample to be approved by the Landscape Architect.
 - B. Washed Plaster Sand: Clean, washed, natural or manufactured sand, sharp, fine-textured, free of toxic materials. Sieve tested in accordance with ASTM C136, with 100% passing through a #4 screen, 0% passing through a #200 screen.
 1. Chemical Properties: (by DPTA Saturation Extract Method):
 - a. Soluble Salts/Salinity: Maximum conductivity of 3.0 millimhos/cm at 25 degrees C.
 - b. Boron: Maximum concentration of 1.0 PPM.
 - c. Sodium Absorption Ratio (SAR): Maximum 6.0.
 - d. pH: 7.0.
 - C. Perlite: Horticultural Perlite, soil amendment grade, 6.5 to 7.5 pH.
 1. Unacceptable Materials: Polystyrene beads shall not be used as a substitution for horticultural Perlite.
 - D. Vermiculite: Horticultural Vermiculite, gold-brown in color.
 1. Size: 2-4mm, 5 mesh to 10 mesh sieve size.
 2. Density: 4.5 to 5.5 lb./cu ft.
 3. Grade: #2, Medium Grade.

2.3 INORGANIC SOIL AMENDMENTS

- A. Peat Humus:
 1. Type: Canadian Sphagnum Peat, as derived from the genus Sphagnum, medium-divided, coarse fibrous texture, brown in color.
 2. Measurement: Measure peat in air dry condition, containing not more than 35% moisture by weight on an "as-received" basis.
 3. Physical Properties: Percent Passing Sieve Designation 95 – 100% 9.51 mm (3/8") 0 – 40% 500 micron (No.35)
 4. Organic Content (dry weight basis): Minimum 95%.
 5. Fiber Content: Greater than 66%.
 6. Water Holding Capacity: 20x to 30x its dry weight in water.
 7. Range in Ash Content (%): 1.0 to 5.0.
 8. Chemical Properties:
 - a. Nitrogen (dry weight basis): 0.6-3.0%.
 - b. Salinity/Soluble Salts: Saturation extract conductivity 0.0-3.0 millimhos/cm @ 25 degrees C.
 - c. pH range: 3.0 to 4.0.
 9. Unacceptable Materials:
 - a. Coir Dust.
 - b. Sedge Peat.
 - c. Reed Peat.
 - d. Hypnum Peat.
- B. Mycorrhizal Inoculum
 1. Mycorrhizal Inoculum for Plant Material: Dual soil-conditioning biological inoculum system of endo-and ecto- Mycorrhizal, used to further aid the plants ability to efficiently uptake available soil nutrients and increase resistance to drought.
 - a. Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:

- 1) 7-gram Myco-Pak, Tri-C Enterprises LLC, Chino, CA, 800-927-3311.
 - 2) 4 oz. Packet - Roots 1 Step, Roots, Inc., Independence, MO, 800-342-6173.
 - 3) Or equal, as approved by the Landscape Architect.
- b. Provide at the prescribed application rate, per the Manufacturer's written recommendations.

2.4 CHEMICAL SOIL AMENDMENT COMPONENTS

- A. General: Chemical Soil Amendment Components listed herein may or may not be used, depending on the results of the Agronomic Soil Fertility Report. Provide as required.
- B. Gypsum: Commercially-processed and packaged agricultural-grade hydrated calcium sulfate product (CaSO_4), 92.0% minimum, pH at 7.1.
 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Ben Franklin® No. 1 Agricultural Gypsum, U.S. Gypsum Company.
 - b. 100% Good Stuff Gypsum™, Art Wilson Company.
 - c. CAL-SUL® Pelletized Agricultural Gypsum, North Pacific Group.
 - d. Bumper Harvest Agricultural Gypsum, Domtar Gypsum.
 - e. Premium 97 Solution-Grade Gypsum, Diamond K, Inc.
 - f. Or equal, as approved by the Landscape Architect.
- C. Soil Sulfur: Elemental Sulfur (90% min.) commercially manufactured, water degradable, palletized.
 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Disper-Sul, Martin Resources, Inc.
 - b. Soil Sulfur, Red Top.
 - c. Or equal, as approved by the Landscape Architect.
- D. Iron: Non-staining, 40% Fe minimum, complete with micro-nutrients and 2% humic acids, as derived from iron oxide, manganese oxide, or zinc oxide.
 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the follo
 - a. Gro-Power Iron, Gro-Power, Chino, CA.
 - b. Iron 45 w/ Micronutrients, Tri-C Enterprises LLC, Chino, CA.
 - c. Or equal, as approved by the Landscape Architect.
- E. Dolomite Lime: Agricultural-grade mineral soil conditioner containing 35% minimum magnesium carbonate, and 49% minimum calcium carbonate, 100% passing #65 sieve.
- F. Potassium Sulfate (Sulfate of Potash K_2O), (0 guaranteed analysis N-P 2O_5 -K 2O): Agricultural-grade, containing minimum 50% of water-soluble potash and 18% Sulfur (S).
- G. Single Superphosphate P_2O_5 (0 guaranteed analysis N-P 2O_5 -K 2O): Commercial product, containing 15% available phosphoric acid and 14% Sulfur.
- H. Triple Superphosphate P_2O_5 , (0 guaranteed analysis N-P 2O_5 -K 2O): Commercial product, containing 45% available phosphate and 15% Calcium (Ca).
- I. Ammonium Sulfate $(\text{NH}_4)_2\text{SO}_4$, (21 guaranteed analysis N-P 2O_5 -K 2O): Commercial product containing approximately 21% ammonia.
- J. Ammonium Nitrate NH_4NO_3 , (34 guaranteed analysis N-P 2O_5 -K 2O): Commercial product containing approximately 34% ammonia.
- K. Calcium Nitrate CaNO_3 , (15.5 guaranteed analysis N-P 2O_5 -K 2O): Agricultural grade containing 15-1/2% nitrogen.
- L. Potassium Nitrate KNO_3 , (13 guaranteed analysis N-P 2O_5 -K 2O): Commercial product

containing approximately 13% nitrogen and 45% potassium.

- M. Ureaformaldehyde (38 guaranteed analysis N-P2O5-K2O): Granular commercial product containing approximately 38% nitrogen.
- N. Urea CO(NH2)2, (46 guaranteed analysis N-P2O5-K2O): Granular commercial product containing 46% nitrogen
- O. I.B.D.U. (Iso Butyldiene Diurea): Commercial product containing 31% nitrogen.

2.5 FERTILIZERS

- A. Composition: Nitrogen (N), phosphorous (P2O5), and potassium (K2O) content, plus other elements, as indicated.
- B. Fertilizer Tablet:
 - 1. General: Fertilizer Tablet shall be a 7-gram tablet, organic-based, tightly compressed chip-type commercial grade, 12-month slow-release planting tablets, and shall be composed of the following available percentages by weight of plant food: Element/Material Targeted Property Range Nitrogen (N) 12% Minimum Phosphoric Acid (as P2O5) 8% Minimum Potash (as K2O) 8% Minimum Humus 20% Minimum Humic Acids w/ micronutrients and soil enhancers 4% Minimum
 - 2. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, provide products by one (1) of the following:
 - a. Gro-Power 12 Planting Tablets, Gro-Power.
 - 1) Application Rate: As indicated herein Part III this Section.
 - b. Or equal, as approved by the Landscape Architect.

2.6 ACCESSORIES

- A. Drain Rock/Aggregate: Crushed Stone, conforming to ASTM C33, graded to ¾"-size, clean, hard, durable, free of materials toxic to plant growth, set in bottom of Planters, at depth indicated in Contract Drawings. Provide Geotextile Filter Fabric between Drain Rock/Aggregate and amended planting backfill soil.
- B. Wetting Agent/Water Storing Polymer: Non-biodegradable, granular, polyacrylamide polymer soil amendment.
 - 1. Commercial-Grade Products & Manufacturers: Subject to compliance with requirements, approved through submittal.
- C. Landscape Mulch Material:
 - 1. Organic Wood Mulch: Refer to plans for type and size.
 - 2. Rock Mulch: Refer to plans for type and size.
 - 3. Crushed Stone: Refer to plans for type and size.

PART 3 - EXECUTION

3.1 ARGONOMIC SOIL FERTILITY REPORT/RECOMMENDATION

- A. Once rough grading has been accomplished, and prior to commencing Soil Preparation operations, (amendments, fertilizers, etc.), soil samples shall be taken from representative areas and below grade depths of the Project Site. Locations and depths to gather the representative soil samples shall be accomplished by the Contractor under the direction of the Landscape Architect.
 - 1. Provide a minimum of ten (10) Soil Samples from locations to be coordinated.
- B. Guidelines for Selecting the Soil Samples:
 - 1. Select representative areas to sample. The area needs to be uniform in color, texture, depth, and drainage with the same fertilizing program and type of use. Planting areas to receive lawns, flowerbeds, trees, cut areas, fill areas, etc. should be tested separately. An area containing multiple trees and shrubs can be grouped into one area if the planting is the same.

2. Depths and process of soil sampling:
 - a. Sample as deep as the soil will be amended, generally six-inches (6") deep for groundcover/lawns, eighteen-inches (18") deep for shrub areas, twenty-four-inches (24") deep for small boxed trees, and three-feet (3') to four-feet (4') for large boxed trees.
 - b. Use a soil probe or soil auger to remove a core sample; otherwise, use a shovel to dig a hole to the desired depth. Sample the soil from the side of the excavated hole, scraping the side with a trowel. The tools used for digging shall be clean and not rusty. Avoid sampling when the soil is too wet.
3. In desired areas where multiple sub-samplings are taken from any one (1) area to create a combined sample, mix the sub-samples homogenously together in a clean plastic bucket prior to placing in the plastic bag.
4. Each Sample shall be sent directly to the laboratory in a separate, re-sealable, one (1)-gallon plastic bag. Provide a minimum of four (4) cups of soil within each respective sample to allow for adequate testing.

3.2 SOIL PERCOLATION TESTING

- A. Type/Quantity: During operations of Agronomic Soil Fertility Testing and prior to installing Plant Material, Contractor shall perform Soil Percolation Tests, through the direction of the Landscape Architect, in selected representative areas of the Project Site, to verify acceptable natural drainage, soil structure, and soil composition. Contractor shall verify the locations of the Soil Percolation Tests with the Landscape Architect
 1. Required Number of Soil Percolation Tests: ten (10)
- B. Procedure: Each Soil Percolation Test shall be performed as follows:
 1. Dig a hole: 2'-0" wide x 2'-0" long x 2'-0" deep.
 2. Fill the hole with water to top and cover with plywood and barricade. Allow hole to drain and fill again to top.
 3. Make daily observations, noting the depth of water each day.
 4. Report findings, in writing, to the Landscape Architect. Include the length of time the water takes to drain completely from each hole, date of test, location, and other information, which may be useful in providing further recommendations.
- C. Results: Based on the combined results of the Agronomic Soil Fertility Testing and the Soil Percolation Tests, Contractor may be required to install additional tree drainage sumps or other drainage methods at each planting pit for trees larger than 15-gallon container stock. Contractor shall include, as a line-item price within the Base Bid, the price per each additional tree drainage sump, should they be required (based on the testing).

3.3 SOIL MOISTURE CONTENT

- A. General: Do not work soil when moisture content is so great that excessive compaction occurs, or when it is so dry that dust will form in air, or that clods will not break readily. Apply water, if necessary, to bring soil to an optimum moisture content for tilling and planting. Soil moisture level prior to planting shall be no less than 75% of field capacity. The determination of adequate soil moisture for planting shall be the judgment of the Landscape Architect. Range: Maintain within tw

3.4 CLEARING, CULITIVATION, & EXCAVATION

- A. Clearing: Clear planting areas free of stones two-inches (2") in diameter and larger, weeds, debris, and other extraneous materials prior to soil preparation Work.
- B. Pre-Plant Weed Control:
 1. Clear and remove existing weeds by spraying and grubbing to at least one-inch (1") below the soil surface.
 2. Dead weeds shall be cleared and removed prior to planting
 3. Maintain a weed-free Project Site until final acceptance by the Owner, utilizing mechanical, chemical, or manual treatment.

- C. Cultivation of Native Site, with Amendments/Fertilizers:
1. Verification: In planting areas where Native Topsoil blend will be applied, verify that sub-grades prior to installation of Topsoil have been established under rough grading. Do not spread Topsoil prior to acceptance of sub-grade Work.
 2. Cultivation: Following Pre-Plant Weed Control operations, rip or cultivate verified planting areas of Native Site Soil at the indicated depth, prior to applying Imported Topsoil (if required) and Soil Amendments/Fertilizers.
 - a. Depth of Cultivation for existing soils: As specified in Drawings or minimum 8-inches (8").
 - b. Depth of Excavation for imported soils: As specified in Drawings or minimum 8-inches (8").
 3. Following initial cultivation or excavation of existing Native Site Soil, evenly spread Imported Topsoil (if required) throughout all planting areas at the minimum indicated depth to meet finished landscape grades.
 - a. Minimum of eight-inch (8") at Landscape Beds or Mass Planting areas.
 - b. Minimum of four-inches (4") at Sodded areas.
 - c. Minimum of two-inches (2") at Permanent Seeded and Hydroseeded areas.
 4. Once Imported Topsoil has been spread, uniformly broadcast all required Soil Amendments and Fertilizers as recommended through the results of the Agronomic Soil Fertility Report.
 5. Thoroughly cultivate/blend all materials to provide a homogenous planting soil mixture at the indicated depth:
 - a. Depth of Cultivation: Minimum eight-inches (8").
 6. Lightly tamp/compact prepared Planting Soil to eliminate settlement, and complete finish grading operations.
 7. Planting Soil Amendment Schedule: The Planting Soil Amendment Schedule shall be based on the combined results of the Agronomic Soil Fertility Tests and Percolation Tests and recommendations provided by the Testing Agency/Lab.

3.5 APPLICATION RATES

- A. Fertilizer Tablets shall be spread equidistantly around the perimeter within the Amended Planting Backfill Mixture, up to within three-inches (3") of the finished grade of the Mixture, and at the following rates: Size of Plant Material Total Quantity of 7-gram tablets One (1)-gallon Container stock. One (1) Tablet Five (5)-gallon Container stock. Nine (6) Tablets Fifteen (15)-gallon container stock Fifteen (10) Tablets 2.5" Caliper Stock Fifteen (15) Tablets 3"-4" Caliper Stock Twenty
1. Contractor shall not provide Fertilizer Tablets for designated native plant species, if directed by the Landscape Architect. Contractor shall verify with the Landscape Architect, in writing, as to which plants are subject to not receive the Fertilizer Tablets.
- B. Mycorrhizal Inoculum Application Rate:
1. During application of Fertilizer/Planting Tablets, Mycorrhizal Inoculum shall be spread equidistantly around the perimeter within the Amended Planting Backfill Mixture, up to within three (3") inches of the finished grade of the Mixture, at the prescribed application rate per the Manufacturer's written recommendations.

3.6 DRAINAGE OF PLANTING AREAS

- A. Surface Drainage:
1. Discrepancies: Provide proper surface drainage of planted areas. Submit in writing all discrepancies in the Contract Drawings or Specifications, or prior Work done by others, which Contractor feels precludes establishing proper drainage.
 2. Correction: Include description of work required for correction or relief of said

condition

B. Detrimental Drainage, Soils and Obstructions:

1. Notification: Submit in writing all soils or drainage conditions considered detrimental to growth of plant materials. State condition and submit proposal and cost estimate for correcting condition.
2. Correction: Submit for acceptance a written proposal and cost estimate for the correction before proceeding with Work.
3. Obstructions: If rock, underground construction Work, tree roots, or other obstructions are encountered in the performance of Work under this Section, submit cost required to remove the obstructions to a depth of not less than six-inches (6") below the required soil depth.

3.7 MAINTENANCE

- A. Protect graded areas from traffic and erosion. Keep free of trash and debris. Repair and reestablish grades in settled, eroded, and damaged areas.
- B. Where completed areas are disturbed by construction operations or adverse weather, scarify surface, reshape, and compact to required density.

3.8 WASTE MATERIALS

- A. Haul from site and legally dispose of waste materials including trash and debris as required and approved by the owner typical.

3.9 CLEAN UP

- A. Upon completion of filling and grading work, remove equipment and tools. Leave site clear, clean, free of debris and ready for subsequent trades work.

END OF SECTION 329113

**SECTION 329200
TURF AND GRASSES**

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide sodded lawns as shown and specified. The work includes:
 - 1. Soil Preparation
 - 2. Sodding lawns and other indicated areas.
 - 3. Maintenance.

1.2 QUALITY ASSURANCE

- A. Sod: Comply with American Sod Producers Association (ASPA) classes of sod materials.
- B. Provide and pay for materials testing. Testing agency shall be acceptable to the Architect. Provide the following data:
 - 1. Test representative materials samples proposed for use.
 - 2. Topsoil:
 - a. pH factor.
 - b. Mechanical analysis.
 - c. Percentage of organic content.
 - d. Recommendations of type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.

1.3 INFORMATIONAL SUBMITTALS

- A. Submit sod growers certification of grass species. Identify source location.
- B. Submit the following materials certification:
 - 1. Fertilizer(s) analysis.
- C. Submit materials test report.
- D. Upon sodded lawn acceptance, submit written maintenance instructions recommending procedures for maintenance of sodded lawns.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Cut, deliver, and install sod within a 24-hour period.
 - 1. Do not harvest or transport sod when moisture content may adversely affect sod survival.
 - 2. Protect sod from sun, wind, and dehydration prior to installation.
 - 3. Do not tear, stretch, or drop sod during handling and installation.

1.5 FIELD CONDITIONS

- A. Work notification: Notify Architect at least 7 working days prior to start of sodding operations.
- B. Protect existing utilities, paving, and other facilities from damage caused by sodding operations.
- C. Perform sodding work only after planting and other work affecting ground surface has been completed.
- D. Restrict traffic from lawn areas until grass is established. Erect signs and barriers as required.
- E. Provide hoses and lawn watering equipment as required.

1.6 WARRANTY

- A. Provide a uniform stand of grass by watering, mowing, and maintaining lawn areas until

final acceptance. Re sod areas, with specified materials, which fail to provide a uniform stand of grass until all affected areas are accepted by the Landscape Architect.

PART 2 - PRODUCTS

2.1 TURFGRASS SOD

- A. Reference plan for turf material type.
- B. Provide well-rooted, healthy sod, free of diseases, nematodes and soil borne insects. Provide sod uniform in color, leaf texture, density, and free of weeds, undesirable grasses, stones, roots, thatch, and extraneous material; viable and capable of growth and development when planted.
- C. Fertilizer:
 - 1. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.
 - a. Fertilizer with a ratio of 20 for establishing sod areas.
 - b. Fertilizer with a ratio of 30 for maintaining the lawn.
- D. Water: may not be available on site. Landscape contractor will provide necessary hoses and other watering equipment required to maintain and complete work. An automatic/drip irrigation system will be installed simultaneously with the landscape planting. The landscape contractor shall not anticipate the use of the irrigation system during installation of this contract.
- E. Lime: Apply appropriate rate of pelleted lime as the pH test indicates. No lime is needed if the pH test is between 6.0-7.0.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine finish surfaces, grades, topsoil quality, and depth. Do not start sodding work until unsatisfactory conditions are corrected.

3.2 PREPARATION

- A. Limit preparation to areas which will be immediately sodded.
- B. Loosen topsoil of lawn areas to minimum depth of 4". Remove stones over 1" in any dimension and sticks, roots, rubbish, and extraneous matter.
- C. Grade lawn areas to smooth, free draining and even surface with a loose, uniformly fine texture. Roll and rake; remove ridges and fill depressions as required to drain.
- D. Apply Type A fertilizer at the rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (220 lbs./acre). Apply fertilizer by mechanical rotary or drop type distributor, thoroughly and evenly incorporated with the soil to a depth of 3" by disking or other approved methods. Fertilize areas inaccessible to power equipment with hand tools and incorporate it into soil. Buffalo Grass Sod may not require fertilizer submit soil test for review by Landscape Architect.
- E. Dampen dry soil prior to sodding.
- F. Restore prepared areas to specified condition if eroded, settled, or otherwise disturbed after fine grading and prior to sodding.

3.3 INSTALLATION

- A. Sodding:
 - 1. Lay sod per plans to form a solid mass with tightly-fitted joints. Butt ends and sides of sod strips. Do not overlay edges. Stagger strips to offset joints in adjacent courses. Remove excess sod to avoid smothering of adjacent grass. Provide sod pad top flush with adjacent curbs, sidewalks, drains, and seeded areas.
 - 2. Do not lay dormant sod or install sod on saturated or frozen soil.
 - 3. Install initial row of sod in a straight line, beginning at bottom of slopes,

- perpendicular to direction of the sloped area. Place subsequent rows parallel to and lightly against previously installed row.
4. Peg sod on slopes greater than 3 to 1 to prevent slippage at a rate of 2 stakes per yd. of sod.
 5. Water sod thoroughly with a fine spray immediately after laying.
 6. Roll with light lawn roller to ensure contact with sub-grade.
- B. Sod indicated areas within contract limits and areas adjoining contract limits disturbed as a result of construction operations.

3.4 MAINTENANCE

- A. Maintain sodded lawn areas, including watering, spot weeding, mowing, application of herbicides, fungicides, insecticides and resodding until a full, uniform stand of grass free of weed, undesirable grass species, disease, and insects is achieved and accepted by the Architect at the completion and acceptance of the entire project.
1. Water sod thoroughly every 2 to 3 days, or as required to establish proper rooting.
 2. Repair, rework, and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.
 3. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" height. Repeat mowing as required to maintain specified height. Not more than 40% of grass leaf shall be removed at any single mowing.
 4. Apply Type B fertilizer to lawns approximately 30 days after sodding at a rate equal to 2.0 lbs. of actual nitrogen per 1,000 sq. ft. (140 lbs./acre). Apply with a mechanical rotary or drop type distributor. Thoroughly water into soil. *Only as required per soil test for Buffalo Sod
 5. Apply herbicides as required to control weed growth or undesirable grass species.
 6. Apply fungicides and insecticides as required to control diseases and insects

3.5 ACCEPTANCE

- A. Inspection to determine acceptance of sodded lawns will be made by the Architect, upon contractor's request at the completion of the entire project. Provide notification at least 10 working days before required inspection date.
1. Sodded areas will be acceptable provided all requirements, including maintenance, have been complied with, and a healthy, even colored viable lawn is established, free of weeds, undesirable grass species, disease, and insects.
- B. Upon final acceptance, the Owner will assume lawn maintenance.

3.6 CLEANUP AND PROTECTION

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from sodding operations.

END OF SECTION 329200

**SECTION 329300
PLANTS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Work Included: Provide trees, shrubs, ground covers, native perennials, native grasses and native wildflower and grass seed as shown and specified.
 - 1. Soil preparation.
 - 2. Trees, shrubs, groundcovers, native perennials and native grasses.
 - 3. Mulch and planting accessories.
 - 4. Maintenance and Extended Management.
- B. Related Requirements:
 - 1. Section 015713 "Temporary Erosion and Sediment Control"
 - 2. Section 328400 "Landscape Irrigation Performance Specification" for complete irrigation systems.
 - 3. Section 329200 "Turf and Grasses" for turf (lawn) and erosion-control materials.
 - 4. Section 329400 "Soil Preparation"
- C. Definitions:
 - 1. Plant Material(s) – Refers to living plant species, inclusive of trees, shrubs, groundcovers, vines, ornamental grasses, cacti/succulents, espaliers, annuals, perennials, etc., as indicated in the Contract Drawings.
 - 2. Planting Area (PA) – As denoted on the Contract Drawings, shall refer to areas to be installed with Plant Material(s), or areas where existing vegetation shall be protected.
 - 3. Plant Height – Measurement of main body height, not measurement to branch tip.
 - 4. Plant Spread – Measurement of main body diameter, not measurement from branch tip to branch tip.
 - 5. Amended Planting Backfill Mixture – Refer to Section 32 91 13 – Soil Preparation.
 - 6. Balled and Burlapped Stock – Healthy, vigorous exterior plants with firm, natural balls of earth in which they are grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum laced as recommended by ANSI Z60.1.
 - 7. Balled and Potted Stock – Healthy, vigorous exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.
 - 8. Bare-Root Stock – Healthy, vigorous exterior plants grown with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of exterior plant required.
 - 9. Compacted Settling Layer – Subgrade under where a plant is directly planted.
 - 10. Container-Grown Stock – Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of exterior plant required.
 - 11. Fabric Bag-Grown Stock – Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.
 - 12. Finish Grade – Elevation of finished surface of planting soil.
 - 13. Manufactured Topsoil – Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting

- soil.
14. Multi-Stem – Where three (3) or more main stems arise from the ground from a single root crown or at a point right above the root crown.
 15. Sub-grade – Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.
 16. Subsoil – All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

1. Requirement: Valid Arkansas Landscaping Contractor License.
2. Engage an experienced Installer who has demonstrated completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful landscape establishment.
3. Installer's Field Supervision Installer shall maintain an experienced full-time supervisor on the Project site during times that landscaping installations under this Section are in progress.
4. Selections of Plant Material may be sourced and purchased by the Owner directly. Contractor to provide a line item installation cost and separate warranty identifying the schedule of values for each.

B. Plant Material:

1. Trees, Shrubs, Grasses and Seed: Provide quality, size, genus, species, and variety of Plant Material indicated, complying with applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock."
 - a. At least one (1) plant of each Plant Material species delivered to the Project Site shall have an identification tag from supplying nursery showing botanical and common name of the plant as identified in the Contract Drawings. Landscape Architect shall be provided the opportunity for an on-site debriefing by the Contractor that identifies the size and specific type of Plant Material upon delivery.
 - 1) Provide replacements equal to the size and quality to match the planted materials at the time the untrue species is discovered.
 - b. Replace, at no cost to Owner, Plant Material that is revealed during the course of the Contract as to being untrue to the species indicated in the Contract Drawings and reviewed accordingly under this Section.
 - c. Replacement of Plant Material: Refer to the Guarantee Article indicated herein this Section.

C. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

D. Regulatory Requirements:

1. Contractor shall meet the requirements of applicable laws, codes, and regulations as required by the authorities having jurisdiction over the Work. Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.

E. Permits, Fees, Bonds, and Inspections: Contractor shall arrange and pay for permits,

fees, bonds, and inspections necessary to perform and complete Work under this Section.

F. Plant Material Review and Selection (Tagging):

1. At the discretion of the Landscape Architect, Plant Material will be subject to review, photographed, and selected/tagged by the Landscape Architect at the nursery, or other place of growth, prior to delivery to the Project Site. Contractor shall verify with the Landscape Architect if tagging operations are required.
2. Selecting/Tagging of Plant Materials at the nursery or place of growth does not cancel the right of the Landscape Architect to reject Plant Materials at the Project Site, if damaged or unacceptable conditions are found that were not detected at the nursery, place of growth, or in the submitted photographs.

G. Plant Material Delivery: Plant Material shall be delivered with original Plant Material tagging materials set in place, as selected, and marked by the Landscape Architect at the nursery or place of growth. Seed, topdressing, and any fertilizer materials shall be delivered in original containers. Include materials showing weight, analysis, and names of growers. Store all seed material in a manner to prevent wetting, excessive heating, or other deterioration. Contractor shall notify Landscape Architect upon delivery of Plant Material for review of stock and tagging materials. Plant Materials delivered without original tagging materials, or with broken, damaged, or altered tagging materials, shall be subject to rejection by the Landscape Architect. Rejected Plant Material shall be removed immediately.

H. Pre-installation Conference: Conduct conference at Project Site.

I. Protection of Existing Plant Material:

1. Refer to Requirements specified in Section 015639 – Temporary Tree and Plant Protection.
2. It is the intent of the Contract Documents that certain existing Plant Materials shall be retained. Prior to the removal of any Plant Materials, the Contractor shall confer with the Landscape Architect to determine which Plant Materials are to remain.
3. All existing Plant Materials which are to remain in the project shall be tagged and identified by the Contractor prior to start of Work.
4. Contractor shall be responsible for Plant Materials that are designated to remain. Damage to any Plant Materials which results in death or permanent disfiguration of said Materials shall result in compensation outlined in Section 01 56 39 – Temporary Tree and Plant Protection. The Landscape Architect shall be the sole judge of the condition of the Plant Materials.
5. Existing Plant Materials designated to remain shall be protected at all times from damage by construction activity (tools, materials, equipment, personnel, etc.). Damage by the Contractor to existing Plant Materials shall be repaired at the Contractor's expense to the satisfaction of the Owner, as directed by the Landscape Architect.
6. Contractor shall insure that no foreign material and/or liquid, such as paint, concrete, cement, oil, turpentine, acid or the like, be deposited or allowed to be deposited on soil within the drip line (the outside edge of the foliage overhang) of any Plant Material. Do not store construction materials, debris, or excavated material within drip line of existing Plant Material. Should any such poisoning of the soil occur, the Contractor shall thoroughly remove said soil as directed by the Landscape Architect and replace with acceptable soil at no additional cost to the owner.
7. Excavation adjacent to existing Plant Materials: Where it is necessary to excavate in close proximity to the drip lines of existing Plant Materials, all possible caution shall be exercised to avoid injury to roots and trunk. Excavation close to Plant Materials shall be done by hand, with narrow-tine spading forks or other approved tools to comb soil to expose roots. Tunnel under roots two-inches (2") and larger in diameter. Cutting of roots two-inches (2") and larger shall be only on the approval of the Landscape Architect.

8. Replacement of Damaged Plant Material: Replace existing Plant Material to remain as required, that are damaged by Contractor during construction with accepted Plant Material of the same species, size, and quantity as those damaged, at no additional cost to Owner. Owner shall be the sole judge as to the extent of the damage and the value of said damaged Plant Material.

1.3 SUBMITTALS

- A. General
 1. Collect information into a single submittal.
 2. Submittal shall be organized and presented into specific sections or headings. Furnish neat, concise, legible, and clearly identifiable information, and sufficiently explicit detail, to enable proper evaluation for Contract compliance. Highlight catalog, product data, or brochures containing various products, sizes, and materials to show particular item submitted.
 3. Submittal Format: As applicable, furnish Submittal as a single electronic digital PDF (Portable Document Format) file.
- B. Digital Submittal Information:
 1. Alphabetized List of Plant Material.
 2. Submitted in the following format.
 - a. Project Name
 - b. Botanical Name
 - c. Common Name
 - d. Container Size
 - e. Overall Height
 - f. Caliper Size
 - g. Quantity
 3. The submittal shall not be construed as to acceptance of the plant material. All plant material shall be subject to review and approval by the Landscape Architect upon delivery to the project site.
- C. No work shall proceed under this Section until submittal requirements indicated herein have been review accordingly by the Landscape Architect.
- D. Provide plant material record drawings:
 1. Legibly mark drawings to record actual construction.
 2. Indicate horizontal and vertical locations, referenced to permanent surface improvements.
 3. Identify field changes of dimension and detail and changes made by Change Order.
- E. Submit for the Landscape Architect's approval five samples of each container grown plant under the number 15 container size. The five approved samples shall be retained in a protected location on the project site at a location approved by the General Contractor. The Landscape Contractor shall maintain the sample plants until completion of the site planting. The sample plants may then be used in the site planting.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. General: Do not prune Plant Material before delivery, except as approved by the Landscape Architect. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie Plant Material in such a manner as to destroy natural shape.
 1. Immediately after digging field-grown Plant Materials, pack root systems in wet straw, hay, burlap, or other suitable material to keep root system moist until final planting installation.
 2. Deliver freshly dug field-grown Plant Materials with firm, natural balls of earth of sufficient depth to include fibrous and feeding roots, meeting, or exceeding

- requirements of ANSI Z60.1 for root ball diameter.
3. Store all seed material in a manner to prevent wetting, excessive heat, or other deterioration.
- B. Handling Plant Materials:
1. Handle balled and burlap Plant Material stock by the root ball.
 2. Handle container-grown Plant Materials only by their containers.
 3. DO NOT handle Plant Materials by their trunks or stems.
 4. DO NOT drop any Plant Materials.
 5. DO NOT bind or handle Plant Materials with wire or rope.
 6. Pad trunk and branches of Plant Materials whenever using hoisting cables, chains, or straps.
 7. Should the Contractor engage in handling any Plant Material(s) by any unacceptable method(s), the Landscape Architect shall reserve the right to reject any of the mishandled Plant Material(s). The Contractor shall replace rejected Plant Material(s) with approved Plant Material(s), at no additional cost to the Owner.
- C. Delivery: Provide protective covering during delivery. Deliver Plant Material only after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set Plant Materials in shade, protect from weather and mechanical damage, and keep roots moist. Anchor plants to prevent damage from winds.
1. Heel-in bare-root Plant Material stock. Soak roots in water for two (2) hours prior to planting.
 2. Set balled Plant Material stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 3. DO NOT remove container-grown Plant Material stock from containers before time of planting.
 4. Water root systems of Plant Material stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.5 FIELD CONDITIONS

- A. Work notification: Notify Architect at least 7 working days prior to installation of plant material.
- B. Protect existing utilities, paving, and other facilities from damage caused by landscaping operations.
- C. A complete list of plants, including a schedule of sizes, quantities, and other requirements is shown on the drawings. In the event that quantity discrepancies or material omissions occur in the plant materials list, the planting plans shall govern.

1.6 WARRANTY

- A. Warrant plant material to remain alive and be in healthy, vigorous condition for a period of 1 year after completion and acceptance of entire project.
1. A review of plants will be made by the Architect at Substantial Completion and Final Completion.
- B. Replace, in accordance with the drawings and specifications, all plants that are dead or, as determined by the Architect, are in an unhealthy or unsightly condition, and have lost their natural shape due to dead branches, or other causes such as bark abrasions and misuse of chemicals, due to the Landscape Contractor's negligence. The cost of such replacement(s) is at Landscape Contractor's expense. Warrant all replacement plants for 1 year after installation.
- C. Warranty shall not include damage or loss of trees, plants, or ground covers caused by fires, floods, freezing rains, lightning storms, or winds over 75 miles per hour, winter kill caused by extreme cold and severe winter conditions not typical of planting area, acts of vandalism or negligence on the part of the owner.

- D. Remove and immediately replace all plants, as determined by the Architect, to be unsatisfactory during the initial planting installation.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

- A. Immediately upon award of Contract for Work in this Section, Contractor shall locate and purchase or hold for purchase plant material as required.
 - 1. Contractor shall verify with Landscape Architect of Plant Material that has been nursery "contract grown" by the Owner for use of Work under this Contract.
 - 2. Contractor shall review the condition of the Plant Material with Landscape Architect at the nursery maintaining the Plant Material prior to delivery, and when delivered to the Project Site.
- B. Quality: Plant Materials shall have a growth habit typical for each variety and species indicated in the Plant List (as detailed on the Contract Drawings).
 - 1. All Plant Materials specified shall be superior/premium-grade nursery stock, full, densely foliated, symmetrical, with tightly knit branching, so trained or favored in development and appearance in form, number of branches, compactness and symmetry, healthy, and vigorous in growth, as reviewed and determined by the Landscape Architect
 - 2. Plant Materials shall be free from insect pests, eggs and larvae, plant diseases, sun scalds, fresh bark abrasions, excessive abrasions, windburn, salt burn, weeds, or other disfigurements or conditions, as reviewed and determined by the Landscape Architect.
 - 3. Plant Material shall be subject per the Arkansas State Department of Agriculture's Regulations for Nursery Inspections of Rules and Grading.
 - 4. Growing Conditions: Plant Materials shall be nursery-grown in accordance with good horticultural practices under climatic conditions similar to those of project unless otherwise specifically authorized.
- C. Container Stock (excluding annuals) shall be grown in boxes or containers in which delivered for at least one (1) growing season, but not over two (2) years. Plant Material grown in boxes or containers shall be cultivated during this time to permit full rooting within the specified box or container to bind the planting soil, but not so long as to create a "root-bound" condition.
 - 1. Plant Material shall be completely free of circling, kinked or girdling trunk surface and center roots, and show no evidence of a pot-bound condition.
 - 2. No boxed nor container Plant Material shall be planted which have cracked or broken balls of earth when separated from their boxes or containers.
 - 3. No Plant Material shall be planted with damaged roots, broken root balls, or which are found to be "root-bound" when separated from their containers.
- D. Pruning:
 - 1. Do not prune Plant Materials unless directed by the Landscape Architect.
 - 2. Pruning of Plant Material as grown at the nursery shall conform to ANSI A300 Standards.
 - 3. Consult with Landscape Architect for pruning Plant Materials after delivery and installation.
- E. Measurements: Measure Plant Material according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes.
 - 1. Take caliper measurement at a point on the trunk six-inches (6") above natural ground line for trees up to four-inches (4") in caliper (at a point twelve-inches (12") above the natural ground line for trees over four-inches (4") in caliper).
 - a. Measure foliage across mean foliage dimension when branches are in their normal upright position.

- b. For trees to be supplied in “raised up” condition, foliage origin along main trunk shall be measured from soil line after installation.
 - c. Height and spread dimensions specified refer to main body of plant and not branch tip to tip. Properly trimmed plants shall measure the same in any direction. If a plant is unevenly grown, it shall be classified in the size category of the smallest dimension.
- 2. Size Range: If a range of size is given, do not use Plant Materials less than the minimum size. The measurements specified are the minimum size acceptable and are the measurements after pruning, where pruning is required. Plant Materials that meet the measurements specified, but do not possess a normal balance between height and spread shall be rejected.
- F. Field Dug Stock: Prior to digging of field-grown Plant Materials, ensure that excess loose fill resulting from cultivation around trunks/stems and over roots be removed down to natural finish grade at crown of Plant Materials. During digging, verify that size of tree spade or other equipment is adequate to encompass the actively growing root zone of all Plant Materials. Plant Materials which, after digging, show mostly large fleshy roots and few fibrous roots, will be rejected.
- G. Condition of Root Systems: Plant Materials must prove to be completely free of circling, kinked or girdling trunk surface and center roots and show no evidence of a root-bound condition. Upon inspection by Landscape Architect at the job site, if five-percent (5%) or more of the plants of each species are found to contain kinked, circling or girdling roots, all plants of that species shall be rejected.
- H. Unacceptable Trees: Trees that have damaged, broken, pruned, or crooked leaders will be rejected. Trees having a main leader shall not have been headed back. Trees with abrasions of the bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 3/4 in. which have not completely callused will be rejected.

2.2 TREES

- A. Shade and Flowering Trees: Single-stem trees with straight trunk, well-balanced crown, and intact leader, of height and caliper indicated, conforming to ANSI Z60.1 for type of trees required, subject to review and acceptance by the Landscape Architect. Container-grown trees will be acceptable and shall be subject to meeting ANSI Z60.1 limitation for container stock.
 - 1. Branching Height: 1/2 of tree height, unless otherwise indicated on Contract Drawings.
- B. Small Trees: Small upright or spreading type, branched, or pruned naturally according to species and type, and with relationship of caliper, height, and branching recommended by ANSI Z60.1, subject to review and acceptance by the Landscape Architect. Container-grown trees will be acceptable and shall be subject to meeting ANSI Z60.1 limitation for container stock.
 - 1. Form: As indicated on the Contract Drawings for individual selected species.
- C. Field Dug Specimen Trees:
 - 1. Form and Size: As specified on the Contract Documents for height, spread, and/or caliper, subject to review and acceptance by the Landscape Architect at the supplying nursery prior to delivery and installation. Provide superior quality, full, symmetrical, well-rooted, upright, spreading, with well-balanced crown.
 - 2. Throughout the duration of excavation, transport, delivery, storage, and installation, all Field Dug Specimen Trees shall have their root balls remain moist, firm and intact, with no damage. Provide metal cages, as required, to insure root ball stability. Any tree that exhibits a broken, damaged, or dry root ball at any time under the Contract shall be subject to immediate rejection by the Landscape Architect.

2.3 SHRUBS

- A. Form and Size: Shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of Shrub, subject to review and acceptance by the Landscape Architect. Container-grown Shrubs will be acceptable in lieu of balled and burlapped.
 - 1. Container-grown Shrubs shall be subject to meeting ANSI Z60.1 limitations for container stock, and other requirements as indicated on the Contract Drawings.

2.4 BROADLEAF EVERGREENS

- A. Form and Size: Normal-quality, well-balanced, well-rooted , broadleaf evergreens, of type, height, spread, and shape required, subject to review and acceptance by the Landscape Architect.
 - 1. Container-grown broadleaf evergreens shall be subject to meeting ANSI Z60.1 limitations for container stock, and other requirements as indicated on the Contract Drawings.

2.5 GROUNDCOVERS

- A. Provide ground covers full, established, and well-rooted in removable flats, containers, or integral peat pots, and with not less than the minimum number and length of runners required by ANSI Z60.1 for the container size indicated, and other requirements as indicated on the Contract Drawings, subject to review and acceptance by the Landscape Architect.

2.6 NATIVE GRASSES AND PLUGS

- A. Form and Size: High-quality, established, full, well-balanced, well-rooted, of type, height, spread, and shape required, subject to review and acceptance by the Landscape Architect.
 - 1. Container-grown stock shall be subject to meeting ANSI Z60.1 limitations for container stock.

2.7 PLANT LIST

- A. The plant list including quantities is located on the plans and is for reference only. It is the responsibility of the contractor to determine total quantities in conformance with the plans. Height of plants specified and height of lowest branches of trees is above soil line.

PART 3 - EXECUTION

3.1 INSPECTION

- A. No work under this section shall commence until submittals under this section have been reviewed accordingly by the Landscape Architect.
- B. Prior to commencing Work under this Section, Contractor shall examine previously installed Work from other trades and verify that such Work is complete and to the point where Work herein may commence properly. Do not proceed with Work until unsatisfactory conditions have been corrected.
- C. Installation practices of the Plant Materials shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted horticultural practices, as judged by the Landscape Architect.
 - 1. Soil moisture levels prior to planting shall be no less than seventy-five-percent (75%) of field capacity. The determination of adequate soil moisture for planting shall be in the sole judgment of the Landscape Architect, and their decision shall be final.
 - a. If the soil moisture level is found to be insufficient for planting installation, planting pits shall be filled with water and allowed to drain before commencing planting operations.
 - b. Any planting area that may become compacted in excess of eighty-five-

percent (85%) relative compaction (due to construction operations or other activities during the Contract) shall be tilled and thoroughly cross-ripped to a minimum depth of nine-inches (9") to alleviate the condition, taking care to avoid all existing subsurface utilities, drainage, etc.

- c. Do not commence planting installation prior to acceptance of Section 329113 – Soil Preparation.
- D. Contractor shall notify the Landscape Architect, in writing, on the anticipated commencement date and length of duration of the landscape installation.
- E. Preparation of Planting Installation: Lay out individual Plant Material locations and areas for multiple plantings. Stake locations, outline areas, and gain the Landscape Architect's acceptance prior to commencing physical planting installation.
- F. At the discretion of the Landscape Architect, Contractor shall make field adjustments to the planting layout, as required, per the direction of the Landscape Architect. Layout changes made accordingly shall be performed at no additional cost to the Owner.
- G. No more Plant Materials shall be distributed in the planting area on any day than can be installed and watered on that day. Plant Materials shall be planted and watered immediately after the removal of their containers, as applicable.
- H. Contractor shall protect existing and new improvements and systems installed prior to planting installation. Maintain protection in place until completion of Work and Landscape Establishment Period.
- I. Finish Grades for planting areas shall have been established by the Landscape Contractor prior to Work under this Section. Verify that grades are within one-inch plus or minus (1" +/-) of the required finish grade, and that all proper soil amendments and fertilizers have been furnished and installed accordingly as specified (per Section 329113 – Soil Preparation).
 - 1. Maintain positive surface drainage of all planted areas throughout the duration of the Contract.
- J. Pre-Planting: Where Plant Materials are to be pre-planted to permit site improvements to be installed around them, Contractor shall be responsible for the accurate layout and placement of those Plant Materials, as measured to their centerlines. Confirm designated pre-planting operations with Landscape Architect prior to commencing Work. Contractor shall also be responsible for the protection of pre-planted Plant Materials while other Work is taking place around them. Provide automated irrigation, as necessary, prior to installation and functioning of irrigation systems (per Section 32 84 00 – Irrigation Systems).

3.2 EXCAVATION FOR PLANT MATERIALS

- A. General: Upon completion of applicable pre-planting soil preparation requirements indicated in Section 32 91 13 – Soil Preparation, excavate planting hole(s) for Plant Material with scarified vertical sides, with the bottom of the excavated hole slightly raised and compacted at the center to assist drainage and to minimize settlement of the Plant Material. Excavate holes according to the spacing alignment (i.e. hedge spacing, grid spacing, triangular spacing, etc.) and the on-center (O.C.)
- B. Planting areas that have not been excavated prior to planting.
 - 1. Balled and Burlap Plant Material:
 - a. Excavate the planting hole to the width and depth indicated in the Contract Drawings. Depth of the planting hole includes the depth indicated for the compacted setting layer at the bottom of the excavation, where the top of the plant's root collar is two-inch (2") higher than finished grade or as further directed by the Landscape Architect
 - b. Compacted Setting Layer: Provide a crown of a minimum six-inch (6") depth of native planting soil.

2. Container-Grown Plant Material:
 - a. Excavate the planting hole to the width and depth indicated on the Contract Drawings. Depth of the planting hole includes the depth indicated for the compacted setting layer at the bottom of the excavation, where the top of the plant's root collar is two-inch (2") higher than finished grade or as further directed by the Landscape Architect:
 - b. Compacted Setting Layer: Provide a crown of a minimum six-inch (6") depth of native planting soil.
3. Field Grown/Specimen Trees:
 - a. Excavate the planting hole to the width and depth indicated on the Contract Drawings. Depth of the planting hole includes the depth indicated for the compacted setting layer at the bottom of the excavation, where the top of the plant's root collar is three-inch (3") higher than finished grade or as further directed by the Landscape Architect
 - b. Compacted Setting Layer: Provide a crown of a minimum six-inch (6") depth of native planting soil.
 - c. In areas where special subsurface drainage for planting is indicated, tie drainage pipes, as required, into the drain system.
 - d. Excavate planting hole at 3x the diameter of the rootball.
- C. Obstructions: Notify the Landscape Architect immediately if unexpected rock, debris, contaminants, obstructions, or other items that are detrimental to the healthy sustained growth of Plant Material is encountered in the excavation process.
 1. Hardpan Layer: If encountered, drill six-inch (6") diameter holes into free-draining strata or to a depth of ten-feet (10'), whichever is less, and backfill with free-draining material.
- D. Drainage: Notify the Landscape Architect if subsoil conditions show evidence of unexpected water seepage or retention in planting holes.
- E. Time of planting:
 1. Evergreen material: Plant evergreen materials between September 1 and November 1 or in spring before new growth begins. If project requirements require planting at times, other than winter months, plants shall be sprayed with anti-desiccant prior to planting operations.
 2. Deciduous material: Plant deciduous materials in a dormant condition. If deciduous trees are planted in-leaf, they shall be sprayed with an anti-desiccant prior to planting operation.

3.3 INSTALLATION

- A. Balled and Burlapped Plant Material: Set the Balled and Burlapped Plant Material plumb and in center of the excavated hole, with top of the root ball raised above adjacent finish grade as indicated. Set Balled and Burlapped Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the Landscape Architect.
 1. Carefully place the Balled and Burlapped Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set two-inch (2") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation of the Plant Material, handle the Plant Material by its root ball; avoid handling the Plant Material by its trunk.
 2. Once orientation is accepted, carefully remove the burlap and wire baskets from the tops of the root ball and partially from the sides, but do not remove from under the root ball. Do not damage the root ball or any part of the plant. Plant Material shall be rejected if the root ball is cracked or broken before or during the planting

- operation.
3. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
 - a. $\frac{1}{4}$ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
 - b. $\frac{1}{2}$ pound of Granular Soil Conditioning Material & Fertilizer (per Section 32 91 13– Soil Preparation).
 - c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 32 91 13 –Soil Preparation), per the Manufacturer's latest printed instructions.
 4. Backfilling the excavated planting hole:
 - a. Place the Amended Planting Backfill Mixture around the root ball in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets.
 - b. Maintain the plant plumb while working the Mixture around the root ball. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
 - c. Add the Fertilizer Tablets and other amendments, (per Section 32 91 13 – Soil Preparation) as required, at the prescribed application rates indicated herein this Article or if not indicated, per the Manufacturer's instructions.
 - d. Place the final layers of the Mixture, tamping accordingly, to the top of the root ball. Do not place the Mixture on top of the root ball. Pull soil away and exposed root flare. Ensure root flare is planted above finished grade.
 - e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole. Do not cover the top of the root ball with the backfill mixture.
 - f. Thoroughly mix water and Plant Vitamin/Hormone Stimulant in application ratio as recommended by Stimulant Manufacture. Apply liquid matrix in sufficient quantity to thoroughly saturate the basin to settle the Mixture, and to eliminate voids and air pockets. Should any portions of the root mass be exposed, add additional Mixture as needed to thoroughly cover the root mass.
 5. Mulching: Apply mulch in watering basins as indicated on the Contract Drawings. Refer to plans for type and requirements.
 6. Wrapping:
 - a. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
 - b. Wrap trunks of all trees as directed spirally from bottom to top with specified tree wrap and secure in place.
 - c. Overlap $\frac{1}{2}$ the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
 - d. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.
 7. Staking/guying:
 - a. Stake/guy all trees immediately after each tree planting.
 - b. Stake all trees and all multi-trunk trees.
 - c. Flag or color all cables.
 - d. All work shall be acceptable to the Landscape Architect.
- B. Container-Grown and Ball and Burlap Plant Material: Set Plant Material plumb and in the center of the excavated planting hole, with top of the root ball raised above adjacent finish grade as indicated. Set Plant Material in the proper spacing and/or alignment(s) as indicated on the Contract Documents, or as further directed at the Project Site by the

Landscape Architect.

1. For plastic container stock (4" pot, 1-gallon, 5-gallon, 15-gallon, etc.), carefully remove the plant container prior to setting the plant in the excavated hole so as not to damage root ball. Tip container to horizontal position and shake carefully to remove Plant Material. Support root ball during installation to prevent cracking or shedding of soil.
2. Set the Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set one-inch (1") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation of the plant material, carefully handle the Plant Material by its container; avoid handling the Plant Material by its trunk.
 - a. Plant Material with a damaged root ball upon removal of the container, or if the root ball fails to thoroughly hold the soil as it is removed from the container, or if the plant is mishandled or damaged during planting operations, shall be rejected.
3. For Ball and Burlap stock, carefully set whole root ball of the Plant Material stock on the specified setting layer of compacted native soil, with the top of root ball set two-inch (2") above the finished grade to allow for settlement of the Plant Material within the excavated planting hole. Provide the orientation of the Plant Material that is confirmed and accepted by the Landscape Architect. During the process of determining an acceptable orientation, carefully handle the Plant Material by its basket; avoid handling the Plant Material by its trunk or branches. Once orientation is accepted, remove 1/3 of the wire basket so as not to damage the root ball or any part of the plant. Do not remove the bottom of the wire basket. Discard top 1/3, do not bend back or bury.
 - a. Plant Material with a damaged root ball upon placing/planting, or if the root ball fails to thoroughly hold the soil as it is planted, or if the plant is mishandled or damaged during planting operations, shall be rejected.
4. Prepare the Amended Planting Backfill Mixture: Amend each cubic yard (cu/yd) of native soil excavated from the planting hole by incorporating and thoroughly mixing/blending the following:
 - a. ¼ yard of Bulk Composted Organic Soil Amendment Material (per Section 32 91 13 – Soil Preparation).
 - b. ½ pound of Granular Soil Conditioning Material & Fertilizer (per Section 32 91 13– Soil Preparation).
 - c. Add Mycorrhizal Inoculum to the excavated native soil, (per Section 32 91 13 –Soil Preparation), per the Manufacturer's latest printed instructions.
 - 1) Pending the results of the Agronomic Soil Fertility Report, the Amended Planting Backfill Mixture may be modified accordingly to include additional soil amendments or fertilizers (gypsum, iron, potash, etc.) or the ratios as indicated in the Mixture indicated above may be modified.
 - a) The cost of providing modifications to the Amended Planting Soil Backfill Mixture (as recommended through the Agronomic Soil Fertility Report and as directed by the Landscape Architect) shall be borne by the Contractor.
5. Backfilling the excavated planting hole:
 - a. Place the Amended Planting Backfill Mixture around the root ball in the excavated planting hole. Place the Mixture in six-inch (6") lifts, tamping each lift accordingly to settle the Mixture and eliminate voids and air pockets. Foot

- tamp the backfill, as required.
- b. Maintain the plant plumb while working the Mixture around the root ball. When the planting hole is approximately half-backfilled, water thoroughly before placing the remainder of the Mixture.
- c. Add the Fertilizer Tablets and other amendments (per Section 32 91 13 – Soil Preparation) as required, at the prescribed application rates indicated herein this Article or if not indicated, per the Manufacturer's instructions.
- d. Place the final layers of the Mixture, tamping accordingly, to the top of the root ball. Do not place the Mixture on top of the root ball.
- e. Dish and tamp top of the Mixture to form a three-inch (3") deep watering basin centered on the Plant Material's trunk to the rim width of the planting hole. Do not cover the top of the root ball with the backfill mixture.
- 6. Mulching: Apply mulch in watering basins as indicated on the Contract Drawings. Refer to drawings for type and requirements.
- 7. Wrapping:
 - a. Inspect trees for injury to trunks, evidence of insect infestation, and improper pruning before wrapping.
 - b. Wrap trunks of all trees as directed spirally from bottom to top with specified tree wrap and secure in place.
 - c. Overlap 1/2 the width of the tree wrap strip and cover the trunk from the ground to the height of the second branch.
 - d. Secure tree wrap in place with twine wound spirally downward in opposite direction, tied around the tree in at least 3 places in addition to the top and bottom.
- 8. Staking/guying:
 - a. Stake/guy all trees immediately after each tree planting.
 - b. Stake all trees and all multi-trunk trees.
 - c. Flag or color all cables.
 - d. All work shall be acceptable to the Landscape Architect.

3.4 PRUNING AND THINNING OF PLANT MATERIAL

- A. Pruning/Thinning of Tree Canopy
 - 1. At no time shall Plant Material be pruned, trimmed, thinned, shaped, or topped prior to delivery. Pruning, trimming, thinning, shaping, or topping of Plant Material shall be only conducted on the Project Site, and under the presence and direction of the Landscape Architect or approved Certified Arborist. Plant Material that has been pruned and delivered to the Project Site without prior approval by the Landscape Architect or an approved Certified Arborist will be rejected.
- B. When directed by the Landscape Architect or an approved Certified Arborist, Contractor shall prune, thin, and shape plant material, according to standard horticultural practice, to preserve the natural character of the Plant Material.
 - 1. Pruning and remedial work shall be done per ANSI A300.
 - 2. Prune trees to retain required height and spread. Do not cut tree leaders; remove only injured or dead branches from trees.
 - 3. Prune shrubs accordingly to retain natural character.
 - 4. Provide pruning, cabling and bracing, irrigation, pest and disease control and other remedial treatments as recommended to assure the long-term health of the trees and existing vegetation, and the safety of persons and property.
 - 5. Newly planted trees shall be pruned near the termination of the Landscape Establishment Period, per the direction of the Landscape Architect, as required.

3.5 CLEANING AND PROTECTION

- A. During installation operations, keep Work area in an orderly and safe condition. Contractor shall remove trash caused from his Work on a weekly basis throughout the duration of the

Work.

- B. Protect plants from damage due to landscape operations and operations of other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- C. Upon completion of his Work under this Section, the Contractor shall remove rubbish, waste, debris, excess construction materials, surplus soil and other items resulting from construction operations and legally dispose of it off the Owner's property.
- D. Scars, ruts, or other marks in the ground caused by the Contractor's Work shall be repaired.
- E. Remove equipment and implements of service and leave the entire Project Site area in a neat, clean, and Owner-approved condition.
- F. Labels: Remove all nursery-type labels, flags, and or identification markings from Plant Materials AS DIRECTED BY THE Landscape Architect.

3.6 PLANT MAINTENANCE

- A. Maintain the trees, shrubs, groundcovers, perennials, native grasses until Final Completion of the entire project. Upon Final Completion, the Owner will assume maintenance as recommended by the written maintenance instructions submitted by the Landscape Contractor for Sodded areas only.
- B. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, application of appropriate insecticides and fungicides necessary to maintain plants free of insects and disease, and performing other operations as required to establish healthy, viable plantings.
- C. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
- D. Correct defective work as soon as possible after deficiencies become apparent and weather and season permit.
- E. Deep-water trees, plants, groundcover, perennial and native grass beds within the first 24 hours of initial planting, and thereafter as required for healthy growth until final acceptance.

3.7 SUBSTANTIAL COMPLETION

- A. An inspection of the trees, shrubs, groundcovers, perennials and native grasses will be made by the Landscape Architect upon request for Application of Substantial Completion by the Landscape Contractor. Provide notification of at least five (5) working days before requested inspection date.

3.8 FINAL COMPLETION

- A. An inspection of the trees, shrubs and ground covers will be made by the Landscape Architect upon request for Final Completion by the Landscape Contractor.

END OF SECTION 329300